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Three Essays on Children, Women and Economic Development

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Declaration

I hereby declare that this thesis has not been and will not be submitted in whole or in part to another University for the award of any other degree.

Part of this thesis, specifically Chapter 3, has been published in the *World Bank Economic Review* and has been co-authored with Paola Salardi and Patricia Justino.

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Summary

This thesis investigates three important themes within the development economics literature that link children, women and economic development.

In the first essay we present an analysis of child labour among agricultural households in rural Nepal. We first examine the monetary contribution of child labour to family farms. For this purpose, within a non-separable agricultural household model we estimate a farm production function to obtain shadow wages for both children and adults employed on the farm. Our results reveal that the relative contribution of child labour to family income is not negligible. We then analyse child labour supply to explore whether it is driven by poverty or other reasons such as imperfections in the labour market. We estimate both a reduced form model and a structural equation model. This latter includes the estimated shadow wages and income from the previous analysis. Both models allow for an examination of how child labour supply reacts to a change in the opportunity cost of time and wealth. The reduced form results suggest that an increase in household's wealth (measured by land endowments) reduces child labour, specifically of girls. This result is consistent with the hypothesis of poverty-induced child labour in the presence of perfect labour markets. This decline, however, occurs for sufficiently high levels of wealth. Imperfections in the labour market may play a role in explaining child labour of boys and in households that are not at the top-end of the land distribution. Estimates of the structural labour supply model, however, yield results on wage and income elasticities that partly contradicts the theoretical predictions.

In the second essay we analyse whether and how an increase in the participation of women in a key decision making body of local collective action institutions - the Executive Committee (EC) of Community Forest User Groups (CFUG) in Nepal - affects forest protection, specifically household firewood collection. In many developing countries women are responsible for the collection and management of forest products essential to the daily lives of their household. Therefore they have stronger interests than men in ensuring the availability of these products. Despite this, women are often excluded from the decision-making process that sets out the rules to access and collect forest products within community forests. We account for the potential endogeneity of female participation and exploit an amendment made to the guidelines for CFUG formation that sets a higher

threshold for women representation in the Executive Committee to evaluate the impact of women on firewood extraction. The results indicate that higher female participation in the ECs of CFUGs leads to a decrease in firewood extraction. This evidence is suggestive that women are prioritising conservation to ensure sustainable firewood extraction for their daily needs.

In the third essay we analyse the short and long-term impact of violence on education in Timor Leste. Specifically, we examine the effect of the 1999 violence on school attendance in 2001 and its longer-term impact on primary school completion of the same cohorts of children observed again in 2007. We compare the educational impact of the 1999 violence with the impact of other periods of high-intensity violence during the 25 years of Indonesian occupation. The short-term effects of the conflict are mixed. In the longer term, we find evidence of a substantial loss of human capital among boys in Timor Leste exposed to peaks of violence during the 25-year long conflict. The evidence suggests that this result may be due to household trade-offs between education and economic welfare.

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Introduction

This thesis consists of three separate essays devoted to the analysis of links between children, women and economic development. Specifically, we investigate the relationship between children and economic development by looking at the effects of changing economic conditions and of conflict on child labour and education, respectively. We examine the link between women and economic development by analysing the effect of increased female empowerment in local level institutions on environmental degradation.

Each essay investigates themes that are closely connected and on which debates have emerged over the years. However, little research has been devoted to the specific research questions that are the subject of focus in this thesis. In particular, the first essay provides an analysis of child labour in agricultural households which to date has received only modest attention in the literature. This issue is investigated here for rural Nepal. Much of the existing literature has failed to account for the fact that in agricultural households the allocation of children's time depends on both production and consumption choices and that wages are typically unavailable for self-employed individuals. The second essay provides an analysis of collective action institutions focused on forest protection. In particular, it looks at the impact of an increased share of women in the decision making body of these institutions on environmental outcomes, focusing on the quantity of firewood collected by households in rural Nepal. Most of the existing studies do not concentrate on the role of gender in forest and those that do so are mostly based on the use of small case

studies. This analysis thus contributes to a very small existing literature in exploring this extremely important topic. The third essay studies the short-term and long-term effects of the Timor Leste conflict on the educational outcomes of girls and boys. This study contributes to an emerging literature on the long-term effects of conflict on human capital accumulation.

A contribution common to the three essays is the focus on gender. Girls and women appear to react differently than boys and men to changing economic conditions, to empowerment and to violent events. Gender analysis is central to many topics in development economics. The recognition of differences by gender is well established but there are still relevant issues that merit careful investigation. We show that most of the differences by gender in our results are related to the different roles that men and women, boys and girls play within the household. These differences appear particularly acute in rural settings where social norms and gender division of labour exist.

The interest in analysing the link between children's outcomes and economic development lies both in the inherent rights of children to fully develop and in the vital role that children and young people play in every society. A child has his own right to survive, grow and develop. The UN Convention on the Rights of the Child is founded on the premise that the human rights of all children need to be ensured. In addition, children represent the future of every society and their accumulation of human capital leads to economic growth and development (Boyden and Dercon, 2012). An improvement in children's well-being early in their life has long-lasting effects which ultimately manifest themselves when they are adults. Well-established literature emphasizes the impact of negative shocks during childhood or of any other constraint which hinders a child's development on outcomes later in life (Akresh et al., 2012; Almond, 2006; Almond and Currie, 2011; Case and Paxson, 2008; Maccini and Yang, 2009).

In particular, children who work many hours per day, sometimes in harmful activities,

may have their educational or health outcomes adversely affected. A clear identification of what determines child labour may help remove the constraints that also hinder the normal growing-up of a child and his/her human capital accumulation. Similarly, the adverse effects of a conflict on the affected population may come to light not only in the short-term but also in the longer term. This can lead to significant and long-lasting detrimental effects on individual human capital accumulation. Identifying the effects of conflicts and the appropriate interventions to mitigate them, may help improve economic development.

The analysis of the link between women and economic development is also extremely relevant. A growing literature investigates the relationship between the empowerment of women and economic development. Duflo (2012) suggests a two-way relationship. Economic development, by reducing poverty and gender inequality, may improve conditions for women. However, at the same time, policy interventions devoted to empower women may accelerate development. We are particularly interested in the latter relationship. A focus on empowering women lies primarily on equity grounds. Every woman should have the same right as men to have representation at all levels of decision-making. In addition, the participation of women at decision-making levels may have a positive impact on many socio-economic outcomes. These potentially positive consequences of an increased role for women at different levels are based on the observation that women have different interests and preferences to men (Agarwal, 2010b; Chattopadhyay and Duflo, 2004). Some empirical evidence suggests that by empowering women within the household (e.g., by giving them access to credit), within a community (e.g., by increasing their role in local institutions) or on the farm (e.g., by giving them access to land), they tend to invest disproportionately more on child-related outcomes. Hence, if empowering women improves children's outcomes (such that their human capital accumulation increases), or any other socio-economic outcome, this would also favour economic development (Doepke

and Tertilt, 2011; Duflo, 2012).

More specifically, to inform on the relationship between women and economic development, we look at the effect of an increased role of women within community level institutions on environmental degradation. Environmental degradation *per se* may jeopardise economic development. At the same time it has direct consequences on the populations that rely daily on natural resources. The scarcity of such resources poses serious concerns for them. Women can play a significant role in this context as they have primary responsibilities for the collection and use of forest products that are essential to the household's livelihood. However, female participation in forestry has been neglected and recognition and encouragement of the role of women may ultimately prove beneficial for economic development.

Nepal and Timor Leste are particularly suitable countries for our analysis. The reason for focusing on Nepal for an analysis of child labour lies in the fact that such labour is a significant phenomenon that is mainly confined to the agricultural sector and fairly prevalent on most family farms. Among agricultural households, 50 percent of children aged five to 14 years old are involved in some work activity. In addition, agriculture is the major source of income and employment of the large majority of the population.

Nepal is also appropriate for the analysis of the role of women in forestry. The forest represents one of the most important natural resources in the country. However, over the past decades concerns over forest degradation in Nepal have emerged. In addition, despite the fact that women are still largely under-represented at all institutional levels in Nepal, the presence of women in key positions in locally-based forestry protection institutions has been increasing over recent years.

Finally, the Timor Leste conflict is also particularly interesting for the purpose of our analysis. Timor Leste was hit by a long-lasting conflict with Indonesia. This allows an investigation not only of the short-term effects but also the longer term effects of different

peaks of violence and of the whole conflict on educational outcomes. Despite its very vicious nature, this conflict has been largely ignored. Its peculiarity in terms of post-conflict interventions increases the interest in the analysis undertaken here. In addition, the reason to focus on educational outcomes lies in the fact that the effects of 25 years of Indonesian occupation on education have been adverse. Almost ten years after the end of the conflict most of the Timorese population still had little or no education.

The choice of these two countries is also motivated by practical reasons. All essays develop arguments based on the microeconomic theory. Hence the empirical analysis is based on the use of nationally representative household survey data. The relevant authorities in Nepal and Timor Leste have made high quality household survey data available which contain the information needed for our analysis. In addition, in two essays we complement the analysis using two additional datasets, the CFUG Database, which is a census of all Community Forest User Groups created in Nepal, and the Human Rights Violations Database, which contains detailed data on the violence that occurred in Timor Leste. The use of this data provides unique information which is essential for the empirical identification strategies used in these essays.

The specific objectives of this thesis are structured as follows. In the first chapter we examine the monetary contribution of child labour to family farms and then analyse child labour supply to explore whether it is driven by poverty or other reasons such as imperfections in the labour market. We first estimate a farm production function which permits the calculation of child and adult shadow wages and shadow household income. We then estimate child labour supply equations, in both their reduced and structural forms. The second chapter investigates the effect of an increased participation of women in the Executive Committees (ECs) of Nepalese Community Forest User Groups (CFUGs) on the quantity of firewood collected at the household level. As firewood collection is one of the main causes of forest degradation and deforestation, a reduction in its extraction

potentially informs on the effectiveness of CFUGs in protecting the forests. Our hypothesis is that, given the interests of women in ensuring the availability of firewood, an increase in female participation in the ECs of CFUGs reduces the extraction of firewood. In the third chapter, using individual level measures of violence we examine the short-term effect of the 1999 violence on school attendance in 2001. We then exploit the temporal and geographical variation in the incidence of the conflict to assess the longer term impact of the 1999 violence and of early periods of violence on primary school completion in 2007.

Chapter 1

Shadow wages and child labour supply in agricultural households in Nepal

1.1 Introduction

Child labour is a widespread phenomenon around the world. The ILO estimates that around 218 million children aged between five and 14 years are employed in some kind of economic activity (Hagemann et al., 2006). Most of the attention has been concentrated on the widely known forms of child labour, usually located in urban areas (e.g., child labour in the manufacturing and mining sectors, street children and child sexual exploitation). However, little attention has been focused on child labour in the agricultural sector though 'most of working children are found toiling in the fields and fisheries of the world, not in factories' (ILO, 2002, p.5). This form of child labour is usually recognised as not being harmful for children whenever child activities are limited to helping parents for only a few hours per day. This is not only simply part of a normal growing up in a rural area, but it can also have a beneficial effect on the development of children's skills and on their

education. However, child labour in agriculture is classified by the ILO as one of the worst forms of child labour. There is a great number of children involved in difficult agricultural tasks harmful to their health and required to work for too many hours per day. This might also be true for children that work on the family farm as self-employed. This is the most prevalent form of child labour in rural settings of developing countries.

The aim of this paper is to fill an existing gap in the literature and present an analysis of child labour in agricultural households. More specifically, we first examine the monetary contribution of child labour to family farms and then explore why child labour is prevalent in farm households, whether for poverty or for other reasons (i.e., imperfections in the labour market). The poverty hypothesis simply states that parents will not put their children into work if they 'can afford not to' (Basu et al., 2010, p.8).

Knowledge of the value of income generated by children is particularly relevant as it provides information on the opportunity cost of their time (Jacoby, 1993). In particular, the allocation of children's time is the result of a complex household decision process, which depends on resources available and their distribution within the household, on the availability and quality of schools, on the substitution with adult family members or with hired labour and on various market imperfections. For household members that work in wage employment, market wages represents the opportunity cost to these individuals. However, for individuals engaged in on-farm work, typically wages are not available. Simply imputing market wages to self-employed individuals does not provide robust estimates of the value of family labour, both because observations on wages are typically too few and rural labour markets are usually imperfect. Therefore, shadow wages need to be computed.

In addition, understanding the role of poverty as a determinant of child labour in farm households is particularly challenging. The existing literature on child labour provided mixed evidence on this. Only more recently the precise role of poverty has been analysed

providing evidence that children work more in land rich households than in land poor ones, not for poverty reasons but, under certain conditions, due to the existence of market imperfections (Basu et al., 2010; Bhalotra and Heady, 2003; Dumas, 2007). In particular, the recognition that land has a dual role, being both a source of wealth and also a source of work opportunity, sheds light on the apparently perverse response of child labour to an increase in land in agricultural households. This phenomenon has been termed the 'wealth paradox' and has been attributed mostly to imperfections in the markets (Bhalotra and Heady, 2003). More recent evidence has suggested for the existence of an inverted-U relationship between child labour and land. Children tend to work more as land size increases. However, at a certain level of wealth, child labour starts to decrease. This pattern is also a consequence of imperfections in the labour markets (Basu et al., 2010).

The specific objectives of this analysis are as follows. First, we want to establish what is the contribution of child on-farm labour to the household income and look at child contribution as compared to adults. Within a non-separable agricultural household model we estimate a farm production function to obtain shadow wages of child and adult labour employed on the farm. Second, we want to know how child labour supply in agricultural households reacts to changing economic conditions to understand whether children work mainly because their families are poor or because of imperfections in the labour market. In order to address this objective, we first estimate a reduced form model where land is used as the main source of wealth. The sign on the land coefficient should inform on the relative strength of income and substitution effects stemming from an increase in land size. We then estimate a structural child labour supply equation. In addition to providing useful information in its own right, the shadow wage and income variables can be included in the structural labour supply model to investigate their effects on child labour supply. We obtain direct child wage and household income elasticities that should permit the calculation of pure income and substitution effects. Moreover, the inclusion

of adult shadow wages provides information on the interaction between adult and child labour. This analysis allows an examination of how child labour supply changes when either the opportunity cost of her time changes or the family income changes thus testing the poverty hypothesis noted earlier.

Our results show that the relative contribution of child labour to the family income of farm households is not negligible and that child labour contribution is nearly half of those of adults. In addition, the reduced form results suggest that an increase in land size decreases child labour, particularly of girls. However, this decrease only occurs for relatively high levels of wealth. This suggests that imperfections in the labour market may play a role in explaining child labour of boys and of households that are not at the top-end of the land distribution. Estimates of the structural labour supply model reveal results on wage and income elasticities that are partly contrary to the theoretical priors.

This analysis is conducted on agricultural households in Nepal. This is a particularly interesting country to study as child labour is quite a sizeable phenomenon and is mainly confined to the agricultural sector. Indeed, despite the high incidence of child labour in the worst industries and occupations, and the increasing prevalence of child labour in non-agricultural activities, most of the children in Nepal are involved in some agricultural activity and a great part of it is within their own household (CBS, 2004). In addition, most of the population in Nepal lives in rural areas and the agricultural sector is the major source of Nepalese income and employment. Agriculture accounts for 40 percent of its GDP and nearly 80 percent of the population is involved in some agricultural activity (FAO, 2007). Hence knowing whether and how child labour contributed to Nepalese agricultural income becomes particularly relevant.

With this analysis we attempt to contribute to a limited literature that provides estimates of the shadow wage of children and that in general focuses on child labour in agricultural households. To our knowledge there are no studies that have estimated the

economic contribution of child on-farm labour and then have used this value to estimate a structural child labour supply equation and there is only one study that provides estimate of child shadow wages.

The knowledge of the monetary contribution of child labour to family farms and of how child labour reacts to an increase in wealth or of work opportunities is particularly relevant for policy makers who wish to explore the relative benefits of different policy options (Singh et al., 1986). In particular, if poverty is the main cause of child labour, policies which ban child labour or impose trade sanctions on it, will only worsen the conditions of these households. Any intervention devoted to improve schooling outcomes through a reduction of schooling fees or an improvement of school quality may not have the desired effects if these interventions are not accompanied by lowering the opportunity cost of schooling (Bhalotra, 2007). So programmes which give cash or food to families for sending their children to school would be consistent with poverty being a binding constraint. However, if imperfections in the labour market explain partly the existence of child labour in farm households, then interventions devoted to their removal would be more effective (Basu et al., 2010).

The structure of the chapter is organised as follows. Section 1.2 contains a brief literature review. In Section 1.3 we present the theoretical framework. Section 1.4 provides the empirical strategy. Section 1.5 illustrates the context and section 1.6 describes the data and some descriptive statistics. In Section 1.7 and 1.8 we report the empirical estimates of the production function and those of the labour supply functions respectively. Section 1.9 discusses the results and section 1.10 concludes.

1.2 Literature review

According to the ILO's 2002-04 Global Estimates on child labour, around 132 million children aged five and 14 years work in agriculture (Hagemann et al., 2006). In 2007 the

ILO and FAO together with other international and union organizations signed a declaration of intent of cooperation on child labour in agriculture, directed at its elimination. In addition, the approval of the United Nations Convention of Human Rights of the Child in 1989, the adoption of ILO's Convention 138[1] and 182[2] and the institution in 1992 of the International Program for the Elimination of Child Labour (IPEC), testify to an increasing willingness to address the problem of child labour in developing countries. The Government of Nepal ratified ILO conventions 138 and 182 respectively in 1997 and in 2002. In addition, the Constitution of Nepal of 1990 and four other laws[3] contain specific provisions to protect children, to prohibit the use of child labour in specific occupations and those below a certain age. The Government of Nepal, with the help of international organisations, has been and is currently active in promoting the development of programmes towards the elimination of child labour (e.g., Nepal's Master Plan for the Elimination of Child labour).

Child labour has received special attention in the last two decades and a vast theoretical and empirical literature has emerged over time. Basu and Van (1998) in their seminal paper on the economics of child labour identify poverty (i.e., the luxury axiom) as its main determinant. The luxury axiom predicts that child leisure is a luxury good and households would not make their children work unless they needed to do so for poverty reasons. However, much of the subsequent literature contains mixed evidence on the linkage between poverty and child labour (Psacharopoulos and Patrinos, 1997; Ray, 2000; Sedlacek et al., 2005). The inclusion of a measure of household income or of household assets to analyse the poverty hypothesis, reveals either positive, negative or even zero elasticities. The difficulty in empirically detecting a central role for poverty is linked to the

[1] Adopted in 1973 and concerns the minimum age for admission to employment (see www.ilo.org).

[2] Adopted in 1999 and concerns the 'prohibition and immediate action for the elimination of the worst forms of child labour' (see www.ilo.org).

[3] The Children's Act, 1992; The Labour Act, 1992, and Labour Rules, 1993; The Child Labour (Prohibition and Regulation) Act, 1999; Kamaiya Labour Probihition Act, 2001 (see www.ilo.org).

fact that most of the past literature failed to understand that different economic conditions can affect child labour and school participation in different ways (Edmonds, 2008). Indeed depending on the measure used, this might reflect a mix of demand and supply factors and of income and substitution effects (Bhalotra and Heady, 2003; Dumas, 2007). In addition, shocks can affect households differently depending on their aggregate/idiosyncratic or temporary/permanent nature (Beegle et al., 2006; Dehejia and Gatti, 2002; Duryea et al., 2007; Guarcello et al., 2010; Jacoby and Skoufias, 1997; Kruger, 2007). More recent empirical studies have attempted to understand whether and to what extent poverty is the main determinant of child labour (Edmonds, 2008). This evidence has stressed the need to clearly identify income and substitution effects from different components of family income (Soares et al., 2012) and to separate supply from demand factors (Kambhampati and Rajan, 2006) in order to obtain findings consistent with the predictions of the existing theory (i.e., that poverty is one of the causes of child labour). Soares et al. (2012), find that an increase in family wealth reduces child labour and increases schooling, while an increase in child labour demand (proxied by the value of coffee production and overall agricultural production), raises a child's opportunity cost of time, hence increasing child labour and reducing school participation. Bhalotra (2007), which provides the first direct test of the poverty hypothesis, looks at the own wage elasticity of child labour supply in Pakistan and finds a negative wage elasticity for boys suggesting that the income effect prevails over the substitution effect in support of the poverty hypothesis. The author finds, instead, a wage elasticity for girls not statistically significant from zero and suggests that girls work even when not necessary. However, the analysis concentrates on wage work, where typically the incidence of child labour is quite low (though prevalent in this context). Indeed, most of the existing studies devoted to the analysis of child labour determinants do not focus specifically on child labour in agricultural households.

The analysis of the role of poverty as a determinant of child labour becomes par-

ticularly difficult in agricultural households (i.e., households that own or cultivate some land). Indeed, in these households supply factors and some of the demand factors may come both from within the household. Singh et al. (1986) present a formal agricultural household model showing the complexities with agricultural household behaviour given the interrelation between consumption and production choices. A few studies have analysed the allocation of children's time within an agricultural household (Mueller, 1984). One of the first analyses on this is Bhalotra and Heady (2003). They emphasize the fact that land has a *dual role* being on one side a source of wealth (supply factor) and on the other, a source of employment opportunities (demand factor). They find a positive effect of land size on child labour (i.e., wealth paradox) as greater employment opportunities within the household become available. Imperfections in labour markets may create this paradox (de Janvry et al., 1991). Indeed, assuming that the marginal product of child labour on the farm is increasing in land size, an imperfect labour market (e.g., manifested by difficulty in hiring labour) pushes the household to employ its children on the farm until the wealth effect of land ownership does not prevail. Similarly, Mueller (1984), finds that the more productive capital (i.e, land and education) a household owns, the more its members work, mainly male children. Dumas (2007) also focuses on child farm labour and develops a model to test the poverty hypothesis in rural areas of Burkina Faso.[4] The empirical evidence does not support this hypothesis suggesting instead a major role for rural labour markets imperfections. The author finds indeed that child labour increases as land increases in the presence of market imperfections. However, the study shows that when labour markets are perfect, child labour is decreasing in land. In a recent paper Basu et al. (2010), building on the above two studies, develop a theoretical model and test empirically the poverty hypothesis, more specifically they test the *inverted-U hypo-*

[4]More specifically in testing for poverty she distinguish between the subsistence hypothesis, (i.e., children work only if the household income is below a subsistence level) and a luxury hypothesis (i.e., child labour is a luxury good).

thesis. Under imperfect labour markets they show in India that as landholdings rises, this generates employment opportunities for household family members and children will start working. There is, however, a level of land beyond which child labour starts decreasing as households become rich enough. If labour markets where perfect and hence, for example, off-farm opportunities available, poor households would have sent their children to work off-farm.

The above studies, despite concentrating on on-farm child labour, estimate reduced form models using land as a measure of wealth and employment potential at the same time. These studies indeed do not provide direct wage and income elasticities and also do not provide a measure of the contribution of child on-farm labour to family income. As wages are typically not available for self-employed in agricultural households, most of the studies that attempted to estimate structural models, had to impute prevailing market wages for self-employed activities (Rosenzweig, 1980). Given the importance of clearly identifying the underlying factors that drive a household decision-making process on the allocation of its members' time, knowing the correct value of child and adult time is essential. The knowledge of child wages on family farm work besides having an informative value on its own, allows the direct estimate of wage and income elasticities. This should be informative to establish the role of poverty as a child labour supply determinant. Skoufias (1994) estimates the determinants of child time allocation in agricultural households and argues the case to estimate the shadow value of child labour in non-market activities given imperfections in the markets and the reliance on too few observations when imputing wages.

Few studies have analysed the economic contribution of child labour to household income when children are employed on the family farm. There are no studies that have estimated the economic contribution of child on-farm labour and then use this value to estimate a structural labour supply equation. Mueller (1984) estimates a household en-

terprise production function in rural Botzwana to derive marginal productivities of family labour (including children) and then estimates individual labour supplies. However, the author uses education and land variables as proxies for productivities in the time allocation equation, without obtaining direct wage and income elasticities. The study finds that child labour contributes significantly to household income only in households which own cattle. Rosenzweig and Evenson (1977) attempted to measure a child's economic contribution to family income. Menon et al. (2005) provide the first study that estimates the shadow wage of children in their work on the family farm in Nepal and find that children's contribution to household income is substantial. Other attempts to estimate shadow wages for on-farm work concentrates only on adult labour (Barrett et al., 2008; Jacoby, 1993; Lambert and Magnac, 1994; Skoufias, 1994). As will be shown, shadow wages are simply the value of marginal products of labour obtained from the estimate of a production function. Jacoby (1993) finds marginal products of male labour higher than female ones. A similar result is obtained by Abdulai and Regmi (2000) for Nepal. Fall and Magnac (2004) estimate a rural household model allowing for different 'tastes' for on-farm and off-farm work among household members. They find that shadow wages for on-farm work is below off-farm wages and rationalise this result as reflecting 'a specific taste for on-farm work' (Fall and Magnac, 2004, p.267), that household members assign to on-farm work. Barrett et al. (2008) estimate the shadow wages for adult family on-farm workers taking into account also the existence of any allocative inefficiency.[5] They then adjust the shadow wages for this measure of inefficiency and estimate the adult labour supply.

Estimates of the shadow wage also provide a measure of the relative productivity of each household member on different types of work either on or off-the-farm. It provides knowledge on the demand for child labour in farm households. The literature on intra-

[5]Simply testing whether the marginal product of labour and market wage are equal gives a test for the presence of imperfections in markets, transaction costs, and in general for allocative inefficiencies in the use of labour inputs.

household time allocation models (Becker, 1965; Gronau, 1977; Fafchamps and Quisumbing, 2003) shows how the allocation of labour within a household depends on the relative productivity of their household members. Udry (1996) shows that plots managed by women are less productive than similar plots controlled by men within the same household, suggesting that a reallocation of inputs might increase farm output. Child and adult family labour are not perfect substitutes assuming that different skills and characteristics will result in different marginal productivities. Menon et al. (2005) take into account differences in child and adult characteristics. They find that the child labour contribution represents nearly two-thirds of the adult contribution, suggesting that the contribution of children's work might be substantial for a poor household in order for it to meet its subsistence needs.

Shadow wage estimates also inform on the relative productivity of family and hired labour. Deolalikar and Vijverberg (1987), assert an imperfect substitution between family and hired labour on the farm given their potentially different effect on output and reject the hypothesis of perfect substitutability. Empirical studies have shown that a failure in a simple test of equality between the estimated marginal products and the prevailing market wage provide evidence of imperfections in the rural labour markets (Barrett et al., 2008; Jacoby, 1993; Skoufias, 1994).

Estimated shadow wages and income, besides providing useful information *per se*, are used as regressors to estimate labour supply equations at the individual level to determine how changes in economic conditions and in opportunity costs affect household members' labour supply, controlling for other individual and household characteristics. Skoufias (1994) finds a positive shadow own wage elasticity and a negative shadow income elasticity on the labour supply of males. Jacoby (1993) finds positive uncompensated wage elasticities both for men and women. Breaking down the overall effect of a change in the shadow wage into substitution and income effects, the author finds a positive and signi-

ficant compensated own wage effect (substitution effect), implying that the labour supply is higher as the opportunity cost of time increases and confirming that the household maximises its utility. Abdulai and Regmi (2000) also find positive wage elasticities which are slightly higher for men than for women. Barrett et al. (2008) report a negative wage effect on labour supply when using the marginal product as a measure of shadow wage suggesting a backward-bending labour supply curve. However, when using the shadow wage adjusted for allocative inefficiency they find a positive effect on labour supply, which is more plausible.

1.3 Theoretical framework

In our theoretical framework we follow the general agricultural household model developed by Jacoby (1993). The existence of market imperfections in rural areas of developing countries, makes the non-separability hypothesis (i.e., the fact that farm households' consumption decisions influence production decisions) more plausible. As pointed out in Jacoby (1993), in this general farm household model the separability hypothesis is verified only as a special case. Therefore, there is no need to make the non-separability assumption.

A farm household[6] has preferences over a composite consumption (C) good[7] and leisure (l) which is defined by the following utility function, $U(C, l_i; \mathbf{Z})$, where $\mathbf{Z}$ is a vector of household characteristics. Each household chooses to allocate its members' time endowment among leisure (l_i), on-farm work (F_i) and market work (M_i) where i=adult(a), children (c). Each household member has a total time endowment, $T_i = l_i + M_i + F_i$.

A concave production function describes the farm household produced goods as $Y = \Theta(F_i, H, \mathbf{S}; \mathbf{A})$, where H is the amount of hired labour which the household chooses to em-

[6] We refer here to unitary household models in which any household's decision is taken by the household as a whole and the resources within the household are assumed to be pooled (Alderman, 1995). Collective household models are out of the scope of our analysis.

[7] This includes market goods and home produced goods whose price is normalised to 1.

ploy on the farm, **S** is a vector of variable inputs (e.g., fertilisers, seeds, farm equipments) and **A** is a vector of fixed inputs (e.g., land, quality of land, land use, etc.).

The farm household faces a budget constraint defined as: $C = pY - w_h H + w_i M_i + V$ where w_h is the wage paid to hired labour[8], w_i is the wage paid to household members on market work and V is non-labour income. We introduce a labour market failure such that the household faces the following inequality constraint, $0 \leq M_i \leq \overline{M_i}$ where $\overline{M}$ is the maximum number of hours that a family member can work on the market (Le, 2009). The constraint is binding if either $M = 0$ or $M = \overline{M}$.

The farm household has to solve the following maximisation problem:

$$\max \; U(C, l_i; \mathbf{Z}) \tag{1.1}$$

subject to

$$C = p\Theta(F_i, H, \mathbf{S}; \mathbf{A}) - w_h H + w_i M_i + V \tag{1.2}$$

$$T_i = l_i + M_i + F_i$$

$$0 \leq M_i \leq \overline{M_i} \tag{1.3}$$

where p is the farm output price.

The Lagrangian function can be expressed as follows:

$$\mathcal{L} = U(C, l_i; \mathbf{Z}) + \lambda \left[p\Theta(F_i, H; \mathbf{S}; \mathbf{A}) - w_h H + w_i M_i + V - C \right] + \mu_i^1(\overline{M_i} - M_i) + \mu_i^2(M_i) \tag{1.4}$$

The following first order conditions can be derived. Knowing that $T = l + M + F$ and so

[8] We assume that w_h can be different from w_i for transaction costs and supervision costs.

$M = T - l - F$

$$\mathcal{L}_C : \frac{\partial U}{\partial C} - \lambda = 0 \tag{1.5}$$

$$\mathcal{L}_{l_i} : \frac{\partial U}{\partial l_i} - \lambda w_i + \mu_i^1 - \mu_i^2 = 0 \tag{1.6}$$

$$\mathcal{L}_{F_i} : \lambda \left[p \frac{\partial \Theta}{\partial F_i} - w_i \right] + \mu_i^1 - \mu_i^2 = 0 \tag{1.7}$$

$$\mathcal{L}_H : \lambda \left[p \frac{\partial \Theta}{\partial H} - w_h \right] = 0 \tag{1.8}$$

$$\mathcal{L}_{\mu_i^1} : (\overline{M_i} - M_i) \geq 0 \qquad (\overline{M_i} - M_i)\mu_i^1 = 0 \tag{1.9}$$

$$\mathcal{L}_{\mu_i^2} : (M_i) \geq 0 \qquad (M_i)\mu_i^2 = 0 \tag{1.10}$$

Rearranging we get the following conditions:

$$\frac{\partial U / \partial l_i}{\partial U / \partial C} = w_i - \frac{\mu_i^1}{\lambda} + \frac{\mu_i^2}{\lambda} = w_i^* \tag{1.11}$$

$$p \frac{\partial \Theta}{\partial F_i} = w_i - \frac{\mu_i^1}{\lambda} + \frac{\mu_i^2}{\lambda} = w_i^* \tag{1.12}$$

$$p \frac{\partial \Theta}{\partial H} = w_h \tag{1.13}$$

where w^* is the *shadow wage*.

These conditions, together with the complementary slackness conditions, state that if member i of the household works on the market for some positive hours below the upper threshold, the shadow wage rate will be equal to the market wage paid to household members on market work: $0 \leq M_i \leq \overline{M_i}$ then $\mu_i^1 = 0$, $\mu_i^2 = 0$ and $w_i = w_i^*$. In this case the model is separable. From the first order conditions of the utility maximization problem, family labour supplies are determined as in a standard labour supply model in which the marginal rate of substitution between leisure and consumption equals the wage paid to family labour (in real terms) which in turn equals the market wage. On the other

side, family labour demand is determined by the standard equality of the marginal product of labour to the wage.

Conversely, if member i does not work on the market or her work reaches the maximum number of hours a farmer can work on the market, the shadow wage will be in general different from the market wage. In this case, the marginal rate of substitution between leisure and consumption is equal to the value of the marginal product of on-farm family labour, (i.e., consumption choices affect the production choices).

$$\frac{\partial U/\partial l_i}{\partial U/\partial C} = w_i + \frac{\mu_i^2}{\lambda} = p\frac{\partial \Theta}{\partial F_i} = w_i^* > w_i \quad \text{if} \quad M_i = 0 \tag{1.14}$$

$$\frac{\partial U/\partial l_i}{\partial U/\partial C} = w_i - \frac{\mu_i^1}{\lambda} = p\frac{\partial \Theta}{\partial F_i} = w_i^* < w_i \quad \text{if} \quad M_i = \overline{M_i} \tag{1.15}$$

These expressions convey that, when the constraints on the labour market are binding, the household can be in equilibrium only if the demand for on-farm labour from the production side is equal to the on-farm supply of labour from the consumption side (Elhorst, 1994) with the shadow wage being the price that equates the demand and supply of household labour (i.e., the model is non-separable).

The budget constraint that a household with binding labour constraints faces is non-linear, as its slope (i.e., the marginal product of family labour) is decreasing in family hours worked on the farm. However, the budget constraint is evaluated at the optimum and at this point the budget is linear. Therefore, the approach is to replace the non-linear budget with a linear one (Hall, 1973) which leads to the same optimum. The slope of the budget constraint at this point is the marginal product of family farm labour which, as shown before, is equal to the shadow wage (Jacoby, 1993; Skoufias, 1994).

The household maximisation problem under the linear budget constraint becomes:

$$\max \; U(C, l_i; \mathbf{Z}) \tag{1.16}$$

subject to

$$C + w_i^* l_i = V^* \tag{1.17}$$

where V^* is the *shadow* full income at the household optimum expressed as the *shadow* maximised farm profits plus the non-labour income

$$V^* = \max_{H,F_i} \{p\Theta(F_i, H, \mathbf{S}; \mathbf{A})\} - w_h H - w_i^* F_i + V + w_i^* T \tag{1.18}$$

The solution to this problem yields the traditional Marshallian demand functions for leisure and hence the corresponding labour supply functions for each member of the household i:

$$T_i - l_i = h_i = F_i + M_i = h_i(w_i^*, w_j^*, V^*; \mathbf{Z}) \tag{1.19}$$

where $i = a, c$ and $j = a, c$

The labour supply of each member of the household is defined as the total number of hours worked in various activities (on-farm, off-farm work and housework) which is a function of adult wage, child wage and income. Given the non-separable nature of this model, (i.e., that consumption and production decisions cannot be separated) the difference from a traditional labour supply function is that wage and income are endogenous variables.

We are interested in analysing the effect of changes in the wage of household member i on his supply by decomposing the effect into income and substitution effects. Following Jacoby (1993), by exploiting duality in utility theory, we can minimize equation (1.17) with respect to C and l_i and obtain the expenditure function, $V(w_i^*, u)$. It is then possible to equate the Hicksian and Marshallian labour supply functions as:

$$h_i(w_i^*, w_j^*, u) = h_i(w_i^*, w_j^*, V^*(w_i^*, w_j^*, u)) \tag{1.20}$$

Differentiating with respect to the shadow wages we obtain the following Slutsky equa-

tions :

$$\frac{\partial h_i(w_i^*, V^*)}{\partial w_j^*} = \frac{\partial h_i(w_i^*, u)}{\partial w_j^*} + h_j \frac{\partial h_i(w_i^*, V^*)}{\partial V^*} \tag{1.21}$$

where $i = a, c$ and $j = a, c$

The first component on the right hand side is the own substitution effect which should be positive, while the second is the income effect anticipated to be negative (Ashenfelter and Heckman, 1974). Hence the total *uncompensated* own wage effect is ambiguous and depends on the relative strengths of the above two effects.

1.4 Empirical strategy

The empirical strategy of this analysis consists of two different steps. First, we estimate an agricultural production function in order to obtain the marginal product of labour inputs on the farm. We then obtain the shadow wages and shadow income for the farm household. Second, we estimate labour supply equations for children aged five to 14 years old. More specifically, we estimate a reduced form labour supply equation. Then we estimate a structural labour supply model which include the estimated shadow wages for children and adults in place of their respective market wages, and the shadow income of the farm household.

The agricultural production function is estimated at the household level for households that own and operate some land and in which at least one adult family member works on the farm. The general functional form is given by the following:

$$Y = f(F_a, F_c, H_h, H_x, \mathbf{S}, \mathbf{A}; \beta; \epsilon) \tag{1.22}$$

where Y is the total value of all crops produced and livestock raised by a farm household, F_a, F_c, H_h, H_x are total hours worked on the farm respectively by family adults, family

children, hired and exchange labour[9]; **S** is a vector of other variable inputs (e.g., seeds, fertilisers, farm equipments) and **A** is a vector of fixed inputs (e.g., land, quality of land) and ϵ is an error term. We treat land as exogenous given that the land market in Nepal is not developed and inheritance is the main channel through which land is passed over (CBS, 2006). This is also confirmed by the observation that trading of land is very limited (CBS, 2004).

In the above specification we assume that labour inputs are heterogenous inputs, hence we include them separately in the production process. However, the realisations of family child labour and hired labour might take zero values as not all inputs are employed by each farm. In order to include in the analysis also the observations related to zero input use, we take the logarithmic value for the values greater than zero and retain the zeros when the input is not used.[10]

The error term in the production function might contain unobserved factors (e.g., managerial ability) which can be correlated with other variable inputs and the output measure. Therefore, to control for this potential endogeneity problem, the above models should be also estimated using instrumental variable estimation procedures. We need to find valid and relevant instruments for the variable inputs employed in the production process. This is a quite challenging issue also because we need to instrument more than one variable. We discuss this issue in section 1.7.1.

Our sample might not be a random draw from the population of agricultural households as we only consider households with at least one adult member working on the farm. However, as we will show in the next section, almost all agricultural households have at

[9] We keep separate hired and exchange labour as the decision of using hired or exchange labour might differ across households. This was confirmed also by qualitative interviews during the field work of the author in August 2009.

[10] Another common way, which we also tried without changing the results substantially, is to add one to each input so that the logarithmic transformation takes up the value of zero when the input is not used. Despite this might affect the unit of measurement of the variables, it is a standard procedure in these types of analysis (Barrett et al., 2008; Jacoby, 1993; Le, 2009; Skoufias, 1994).

least one adult member working on the farm. In addition, within the sample we also include households that may or may not have children working on the farm. The decision to employ children or not on the farm might differ by type of household. We test the differences in sample means of some household characteristics to determine what are the relevant differences between these two types of households.[11]

The production function estimates allow for the calculation of the marginal products (i.e., the shadow wages) of family adult and child labour inputs.[12] The shadow wage estimates, as we will explain, are also used for the calculation of the farm household shadow income.

The second step in our empirical strategy consists of the estimation of a child labour supply both in its reduced and structural forms.

First we estimate the following general reduced form equation:

$$h_i = g(\mathbf{A}, \mathbf{Z}, X_i) \tag{1.23}$$

where h_i are hours worked in the past 12 months by children, $i = 1, ...n$, aged between five and 14 years. $\mathbf{A}$ is a vector which includes land size and other variables related to land which, as explained already, we assume to be exogenous; $\mathbf{Z}$ is comprised of household characteristics; and X is a vector of child characteristics. As the hours worked by children are censored at zero if the child does not work, we also estimate our reduced form model using a Heckman two step procedure.

The reduced form equation we estimate follows partly the analysis of Basu et al. (2010) and Bhalotra and Heady (2003). Land has a dual role. It is a source of wealth which can be used to buy child leisure or schooling. It is also a source of opportunity as it can

[11] However, due to data limitations, we do not account in our empirical model for a potential selection process that determines the use of a specific input on the farm.

[12] The specific formula for the calculation of shadow wages depends on the functional form estimated and will be provided in Section 1.7.2.

be used to employ family labour, and thus children on the farm. Under perfect labour markets, as land size increases child labour has to fall. This is consistent with poverty being the cause of child labour, whereby households put their children to work only if they are poor. However, if labour markets are imperfect, the employment opportunities that land generates, may create the paradox that children from land-rich households tend to work more than those from land-poorer households. These imperfections might be due to various reasons. For example, work opportunities outside the home may not be available and family members may only take up work within the household farm; hiring in labour may be difficult (e.g., wages or supervision costs too high, seasonality of work, a general paucity of available labour) and therefore only family labour or exchange labour can be employed on the farm. Therefore, if labour markets are imperfect, a rise in land size can lead to an increase or decrease in child labour. The coefficient on land size sheds light on this relationship. It incorporates both the substitution and income effects. The relative strength of the two effects is an empirical question which we investigate below.

Second we estimate the following general functional form for the structural labour supply equation:

$$h_i = g(\widehat{w}^c, \widehat{w}^a, \widehat{V}, \mathbf{Z}, X_i) \tag{1.24}$$

where $\widehat{w}^c, \widehat{w}^a$ and $\widehat{V}$ are, respectively, the shadow wage of children, adult and the shadow income estimated from the farm production function; the other terms are defined as above. As for the reduced form model, we estimate this structural equation using a Heckman two step procedure to account for censorship in the hours worked by children.

The child shadow wage and the shadow income estimates allow us to compute substitution and pure income effects for the child labour supply function, hence to quantify the relative strength of the two effects. The adult shadow wage informs on the cross-shadow wage effect. However, given the non-separable nature of the model, these measures are

endogenous and instruments need to be found to get consistent estimates. Indeed shadow wage and income are jointly determined with the labour supply. They are functions of household preferences on both consumption and production decisions (Skoufias, 1994). This generates a correlation between the errors in the labour supply and shadow wages and income (Jacoby, 1993). Therefore, we estimate the labour supply equation through OLS and IV regression models.

1.5 Context

Nepal is particularly suitable for this analysis as both the economy is largely based on subsistence agriculture and child labour is a relevant phenomenon in the country. Despite the fact that the Nepalese agricultural sector is becoming more commercialised over the years, agriculture is still largely subsistence and most of the households have to rely on agricultural production of very small parcels of lands. Crop production is mostly dominated by cereals (i.e., paddy, maize, millet, wheat and barley), which account for 80 percent of the cultivated land but also winter potatoes and vegetables account for a good part of the production (CBS, 2006). The geographical distribution of crop production varies somewhat as Nepal is formed of three very different ecological zones each running from east to west and characterised by different microclimatic conditions. The Tarai region in the south has flat and fertile land with a subtropical climate that is very suitable for most crop production. The Hills region in the middle where mostly rice in irrigated or rainfed land and maize or millet in dry land are produced. The Mountains in the north where only a small part of land is suitable for cultivation and in which people mainly raise livestock but also fruits, cereals and potatoes are cultivated.

Nepal underwent through many changes over the last decades. Between 1996 and 2006 Nepal was affected by a conflict between Maoist and government forces. In spite of the conflict enduring for ten years, poverty decreased over the same period. According to

estimates for 2004, child labour increased relative to 1996 (CBS, 2004, 1996). In addition, agricultural wages increased between 1996 and 2004 (CBS, 2006, 2005). Rural daily wages increased from 44 to 55 rupees per day between 1996 and 2004. This substantial increase in agricultural wages may have pushed poverty constrained households to substitute with child labour for more expensive hired labour. This may explain the increase in child labour in Nepal in 2004 relative to 1996. The rise in agricultural wages can be the result of increased opportunities outside Nepal which have lowered the supply of agricultural labour in local labour markets (CBS, 2006). As a consequence farm households may have encountered difficulties in hiring laborers to work on their farms. Recent reports suggest a tightening of the local rural labour market in Nepal in recent years (CBS, 2006).

1.6 Data

Our analysis is based on the Nepal Living Standards Survey of 2003/04 (2004 NLSS Survey) conducted by the Central Bureau of Statistics (CBS) in Nepal. The survey follows the Living Standards Survey methodology developed by the World Bank and is a nationally representative household survey. This survey is the second of two waves which have been conducted in 1995/1996 and in 2010/2011. The first wave (i.e., the 1996 NLSS survey) has already been used by Menon et al. (2005) for the estimation of child shadow wages. There are no studies to our knowledge that use the 2004 NLSS Survey to estimate children shadow wages in agriculture and analyse their labour supply in a sample of agricultural households. This survey was conducted between April 2003 and April 2004 (CBS, 2004). The conflict that prevailed in various parts of the country over this year impeded fieldwork in some of the Primary Sampling Units (PSUs). Therefore eight PSUs in the rural areas could not be enumerated.[13] As a result, the 2004 NLSS survey includes 3,912 households

[13]The missing PSUs are one from the Central, one from the Mid-Western and six from the Far-Western regions. The Far-Western region was indeed one of the areas mostly affected by the conflict. The study of

both from rural and urban areas. The dataset contains detailed information on agricultural households. There is information on crop and livestock production, on land ownership and land use, on seeds and fertiliser use and expenditures, on farm assets and equipment, on the hours devoted to work on the farm by both the household members and by hired labour. All the agricultural data are related to the past agricultural year and thus include two completed growing seasons (dry and wet). Data on child labour for those aged five years or more in wage employment and in self-employment, both in the agricultural and in the non-agricultural sector, is also available. One advantage of this data is that hours of work are also available for domestic work which is typically excluded or unavailable. Ignoring this information would limit sensibly the analysis as it represents, together with on-farm labour, one of the largest components of child labour especially of girls. Ignoring this component, girls would appear to work much less than boys (Basu et al., 2010). Finally, there is extensive information at individual and household level on children and their families in terms of demographics (e.g., age, gender, region of residence, education, occupation, poverty levels, migration, health etc.). One limitation of this data is that unfortunately there is no information on who does what on the farm, hence we cannot measure the productivity on a single activity of each type of labourer. Similarly, we cannot measure the productivity of each type of labourer on different types of plots (i.e., under different modes of land operation).

1.6.1 The production function: sample and variables description

We use for this analysis household level data. As the focus of this study is on agricultural households, the sample under analysis includes only households that cultivate either their own or someone else's land. These represent 77 percent of all surveyed households and we define them as farm households. Among these, most of them (69 percent) own some

the effects of the Nepalese conflict are out of the scope of the current analysis.

hectares of land. Another 24 percent own some land but also cultivate someone else's land. Among these households, the prevailing mode of operation is sharecropping but there is also a small percentage of households which rent in land. A remaining six percent does not own any land but cultivates someone else's land. Most of the households that own or cultivate some land also raise livestock. There are very few households (193 observations) that only raise livestock. We exclude them from the analysis as there is no information on input use other than the labour inputs. Also, we do not place any threshold on the amount of land cultivated in our sample. So any household with hectares of land cultivated greater than zero is included in our analysis. As the average land size is nearly 0.9 hectares, we believe that it is meaningful not to impose any threshold. As explained earlier, we include in the sample only households with at least one adult member working as self-employed on the farm. These represent the 95 percent of households who own or cultivate some land. Finally, we further constrain our sample to include only households that live in rural areas as production and consumption decisions within urban households are driven by different factors and our focus is on the former. In addition, agricultural prices are not available for urban households. Rural households represent 85 percent of the agricultural households considered for this analysis. The final sample includes 2,404 households, which represent the 61 percent of all surveyed households.[14]

Within our sample of farm households 38 percent have children aged 5-14 years old who have worked positive hours on the farm in the past 12 months. As noted in section 1.4, these may be households with different characteristics than those without working children on the farm. Table 1.1 reports the differences in means between farm and livestock production, input use on the farm and some other household characteristics. We note

[14]We have looked at the differences in characteristics between the households selected in the sample and those not. The households in the sample are on average less educated, poorer, of lower caste, with a lower percentage of household head's migration and of bigger household size. These differences suggest that our analysis would be significantly distorted by the inclusion of landless households and those from urban areas (Bhalotra and Heady, 2003).

that households with working children employ, on average, adults and exchange labour for longer hours on the farm than those without working children. These households are characterised, on average, by significantly lower per capita expenditures, by a lower proportion of household heads with secondary or higher education and by a bigger household size than households without working children. In addition, despite the fact that the overall average hectares of land owned or cultivated for someone else is similar between the two groups, when we group the hectares of land into different categories we note that households with working children are characterised by more land of medium size and less land of very small size. Furthermore, the number of available plots seem to be higher for households with children working on-farm. This is suggestive of a greater subdivision of land. Both these statistics may suggest that more people are needed for the cultivation of land, hence the greater number of hours worked by adults and exchange labour in households with working children. We also note that, among households with working children, the number of hours worked by hired labour is lower than the hours worked by family labour or exchange labour. Exchange labour is based on trust rather than hired labour. When extra labour is needed and hiring labour is difficult, labour exchanges among households are frequent. These results are suggestive of a context where tradition and cultural norms prevail and where labour markets seem to fail (de Janvry et al., 1991; Dumas, 2007).

Table 1.2 reports the summary statistics of the variables included in the production function estimation. The output measure in the production function is constructed as the total value of all crops produced and livestock raised by a household. The aggregation of farm production into a single measure and the use of values instead of quantities raise some concerns as price variation might bias the estimates (Le, 2009). As we do not have information on the use of inputs on each single output, the only way we can conduct the analysis is to use an aggregate measure. As information on the input use on each output is rare in this type of analysis, this approach has also been widely used in the literat-

ure (Jacoby, 1993; Skoufias, 1994). We do, however, control for regional price variation dividing crop prices by a regional price index. More specifically, the crop production is measured as the sum of quantity produced times the prices at which each crop is sold on the market. As many households do not sell their products on the market we had to impute prices for the missing information. These are the subsistence households which represent 46 percent of the sample. We report in the Appendix the methodology employed for the price imputation.

Livestock production is measured as the sum of total revenues from livestock products sales (e.g., milk, eggs, meat) plus the 20 percent of the value of livestocks owned. This should take into account the fact that some of the livestock products might not be sold but consumed within the household. The 20 percent is an arbitrary value which has been used in the related literature (Jacoby, 1993). Other values (10, 30, 40 percent) have been tried as well. The estimated coefficients on the production function and the marginal product estimates are mostly invariant to the use of these different thresholds.[15] We are not considering the value of traction animals (i.e., bullocks) as we are not able to establish in what proportion bullocks are used for traction and not for livestock produced goods. Livestock production so calculated is then added to the crop output. Land is included in our production function specification as hectares owned or cultivated for someone else. To account for different uses of land and land tenure contracts, we also include as input measures, the share of land left fallow during the dry or wet season, the share of land rented or sharecropped out (during the dry and wet season) and the share of land rented or sharecropped in. To account for the quality of land we include the share of irrigated land.[16]

The labour inputs are measured as total hours worked on-farm by family adults (from

[15] These results are not reported but are available upon request.

[16] We do not include the share of lowland because is highly correlated with the share of irrigated land. Indeed lowland is termed *khet* and consists of alluvial flat terraces suitable for rice cultivations in the Hills.

15 years old), family children (five to 14 years old), hired workers and exchange labour in the past 12 months. As mentioned earlier, over one-third of the households in our sample use their children on the farm. If we consider the actual hours worked by children, they represent a quarter of the adults hours worked on average (i.e., 850 hours worked over the past 12 months). We distinguish between hired and exchange labour as they might affect the production process in different ways. The dataset gives information on total man-days worked (number of hired persons times number of days worked) by hired and exchange labour.[17] In order to obtain an hourly measure we multiply total man-days by 8 hours. As a robustness check we have also multiplied total man-days by 9 and 10 hours without changing materially the production function estimates.[18] Hired and exchange labour are used by 40 and 64 percent of households respectively. The total actual hours worked on the farm are 207 and 640 hours in the past 12 months respectively, which suggests that exchange labour is a more relevant phenomenon than hired labour. As mentioned above, exchange labour is quite common in Nepal, mainly during the peak season. It is part of Nepalese custom and tradition in a context where the local labour market seems to function imperfectly.

We also include as additional inputs the expenditures on fertilisers, on seeds, on livestock production, other expenses and the value of farm equipment. Though quantity measures would be more appropriate given that input price variation might affect the value of these inputs, we do not have information on the quantity of every input. Therefore, we decided to include the expenditure measures. Other control variables (i.e., education level of the head of the household, regional and interview's season dummies) are also included in our production function specification. The education level of the household head should partly control for unobservable inputs such as managerial ability which should raise

[17] We do not have information on whether hired or exchange labour involves children.
[18] The results are not shown but are available upon requests.

productivity.

1.6.2 The labour supply: sample and variables description

We use for this analysis individual level data. The sample used for the estimation of the child labour supply includes only children 5-14 years old for the same sample of households used for the production function estimate. This is motivated by the fact that the focus of this analysis is on farm households. Among a total number of 5,228 children aged between 5-14 in the 2004 NLSS survey, in our sample of farm households there are 3,564 children aged between 5-14. In Table 1.3 we note that most of the children 5-14 in the sample of farm households are attending school.[19] In addition, we note that one-third of children combine work and school activities. Girls are less able than boys to devote their time to schooling only. Consequently a higher percentage of girls than boys is involved in work only activities. We need to remark that work is defined here as any hour worked in the past 12 months and includes all types of activities including household work. This explains why girls are shown to work more as they are typically involved, more than boys, in household chores and in other activities like firewood collection and fetching water. Among these children, 50 percent have worked in the past 12 months in some activity (i.e., 1774 children). Within this group, 74 percent work on the family farm, while the remainder is involved in other types of activities (which consist mostly of household work). Child wage employment is almost non existent in this sample and, in general, very limited in these types of settings. Finally, we note that among working children, the total hours worked by girls are higher than those of boys, with this difference attributable to household activities.

We have checked descriptively, the relationship between hours worked by children and

[19]Schooling outcomes are out of the scope of this analysis. This is also motivated by the fact that most of the children are attending school.

farm size. Table 1.4 shows these descriptive statistics. We note that the hours worked are declining in farm size. Interestingly, when we split the sample between households who own land, those who own land and cultivate someone else's land, and those that only cultivate others' land, the patterns are different. Indeed we detect a U-shape for households who own land. We detect instead an inverted-U relationship for those who own land and cultivate others' land. This latter pattern, despite being descriptive, is consistent with the inverted-U hypothesis suggested in Basu et al. (2010). It is also consistent with the fact that land which is also sharecropped, should reflect mostly its work opportunity effect with a corresponding weaker wealth effect (Bhalotra and Heady, 2003).

Table 1.5 reports the summary statistics of the variables included in our labour supply estimation. The dependent variable is defined as the total number of hours worked in all types of activities (including housework) in the past 12 months by children aged between five and 14 years old.[20] Nearly half of the children within our sample of farm households do not work and the hours of work are censored at zero for these observations. We will account for this in the next section.

The reduced form specification includes the hectares of land owned or cultivated for someone else as a measure of wealth and work opportunity.[21] When we group the farm size into different categories we note that most of the children live in households of quite small farm size. We see that farm households which own or cultivate land bigger than 2 hectares represent only the ten percent of the sample. We also include in the specification the number of plots owned or cultivated which should capture the subdivision of land when controlling for land size. As explained earlier households may either own land or

[20] We are using the hours worked in the past 12 months on all types of activities to follow the theoretical model outlined in Section 1.3. In addition, using hours worked in the past year better allows smoothing over seasonal fluctuations.

[21] We do not include household expenditures in this specification as an additional wealth measure as land is the most important source of wealth in this context. In addition, consumption measures may also more likely be endogenous to the outcome variable than land. We already mentioned that land markets are almost not existent in rural Nepal. Therefore, the assumption of exogeneity of land seems reasonable.

cultivate land for someone else. Almost one-third of the sample of farm households both own and cultivate the land of others. We need to note that among these households who both own and cultivate others' land the share of hectares sharecropped is almost half of the total hectares owned or cultivated for others, which represents a substantial portion. Hence accounting for the difference in the mode of land operation is quite important as these households may exhibit quite different behaviours. We include dummies to control for these different types of households in the reduced form estimation.

The structural labour supply equation, as explained, does not include any measure related to land size or its mode of operation. This specification includes the relevant parameters (i.e., the shadow wages and income estimated from the farm production function), which allow us to measure income, substitution and cross wage effects. We use the estimated shadow wage of children to measure the opportunity cost of their time and the shadow wage of adults informs on the cross wage effect. The estimated shadow income is our measure of wealth of the household. This is calculated, following Jacoby (1993), subtracting from the predicted output of the production function estimation the total shadow value of family farm work (adult and children work), the value of hired labour, all expenses on all variable inputs, and the value of the rent paid for renting in land. The rent received from renting out land, the value of remittances received and the value of loans are also added as measures of non labour income.

Both the structural and reduced form equations include a set of child and household related characteristics which are usually considered in the analysis of child labour supply. We control for the age and gender of the child. We expect hours worked to be increasing in age and to be higher for girls. The education of the household head, while controlling for sources of wealth, should capture preferences over child labour. Caste and ethnicity should capture instead attitudes towards child labour. The age of the head of the household, his health status and whether he migrated may capture the necessity of children to substitute

for old, ill or migrated adults. However, the education and the migration status of the household head and the caste and ethnicity of the household, may also partly reflect an income effect if it is not fully captured by the wealth measures in the model. Child labour besides depending on the relative strength of income and substitution effects, should also depend on the size and the composition of the household. Once controlling for land size (or for the estimated shadow wage and income), child hours are expected to be decreasing in the number of children aged between five and 14.

1.7 Empirical analysis: the production function

1.7.1 Production function estimates

We first estimate a simple Cobb-Douglas production function of the following form with OLS:

$$\ln(Y_h) = \beta_0 + \beta_1 \ln(A_{h,1}) + \sum_{k=2}^{f} \beta_k A_{h,k} + \sum_{j=1}^{n} \gamma_j \ln(L_{h,j}) + \sum_{s=1}^{m} \delta_s \ln(S_{h,s}) + \epsilon_h \qquad (1.25)$$

where Y_h is the farm output of household h, $A_{h,1}$ is the land input of household h, $A_{h,k}$ are other fixed inputs k (i.e., land quality) of household h, $L_{h,j}$ are the variable labour inputs j which include family (F) and hired (H) labour of household h. $S_{h,s}$ are the other variable inputs s (i.e., seeds, fertilisers, farm equipment, other expenditures).

As mentioned above, not all farm households use all inputs in crop and livestock production. When the logarithmic transformation is not defined for zero input use we retain zero for these values.

The advantage of a Cobb-Douglas production function lies in its convenience for the interpretation of the results. Indeed, all coefficients on the inputs in logarithm represent the estimated elasticities of the output with respect to inputs. Column 1 in Table 1.6 reports the OLS estimates from the Cobb-Douglas production function. All coefficients on

land and on other variable inputs are positive and significant. Specifically, land contributes the most to the production as expected. In particular, a one percent increase in land is associated with a 0.4 percent increase in the output. This estimate is somewhat higher than those found in the related literature (Abdulai and Regmi, 2000; Barrett et al., 2008; Jacoby, 1993) with the exception of Skoufias (1994) who reports a very similar coefficient. These differences may be attributable to the fact that we also control for the mode of operation of land, which few of these related studies in the literature do. The coefficients on the labour inputs are all positive. A one percent increase in adult labour contributes to the 0.28 percent increase in the production. Also hired and exchange labour contributes positively to production but to a lower extent than family adult labour.[22] This is consistent with the hypothesis that family members have stronger incentive than hired labour to contribute to farm production in these types of households (Skoufias, 1994). The child labour coefficient, as expected, is smaller than those on adult labour (family and hired)[23] and is positive and significant. This estimate is consistent with others in the related literature (Abdulai and Regmi, 2000; Jacoby, 1993; Skoufias, 1994). All other variable inputs, as expected, affect positively and significantly the production process. We have tested for constant returns to scale which should characterise Cobb-Douglas production functions. The F-test is 29.2 with a p-value at zero which suggests a rejection of the hypothesis of constant returns to scale. The sum of all coefficients on land and on the other variable inputs is lower than one which suggests for decreasing returns to scale.

The other estimated coefficients on land quality variables are of some interest. In particular, irrigated land contributes positively to farm production. The coefficient on the land sharecropped-in is negative. Hence, once controlling for land size, an increase in the share of land cultivated for someone else, reduces the output which is suggestive of

[22] Differences between coefficients are statistically significant.

[23] Differences between coefficients are statistically significant with the exception of child labour versus exchange labour.

this mode of land operation being less productive. One explanation of this result could be that workers have less incentive to work efficiently if the cultivated land is owned by someone else. Interestingly farm production is increasing in the education of the household head. This is consistent with the role of human capital in agriculture which is expected to enhance land productivity (Huffman, 1977, 1974). The education of the household head may also partly capture the improved managerial ability of the farmer.

As the Cobb-Douglas functional form imposes separability between inputs and a unitary elasticity of substitution among them, we estimate the production function with a more flexible functional form. We allow the marginal rate of technical substitution between two inputs (e.g., between labour inputs) to vary with the level of other inputs as well (Berndt and Christensen, 1973; Christensen et al., 1973). We have therefore estimated a Translog (i.e., transcendental logarithmic) production function using OLS.[24] The purpose of estimating a translog production function here is to verify whether the marginal product estimates of our interest are similar across functional forms. We first estimated the translog production function with all squared and interaction terms between the labour inputs and other variable and fixed inputs. We then estimate a similar specification excluding the squared and interaction terms on child labour. When including these terms there are too many violations of positive and diminishing marginal products of child labour, which is one of the drawbacks of flexible functional forms (Jacoby, 1993). Columns 2 and 3 of Table 1.6 report the estimates of these models. For simplicity of exposition, we report only the interaction terms that are significantly different from zero. We test the joint significance of the squared and interaction terms. The Wald test leads us to conclude that we reject, at a level of one percent, the null hypothesis that the coefficients are jointly equal to zero in both specifications, in support of the Translog functional form (the F-statistics

[24]The general empirical form to be estimated is the following: $\ln(Y) = \beta_0 + \sum_{k=1}^{n} \beta_k \ln(X_k) + \frac{1}{2} \sum_{k=1}^{n} \sum_{l=1}^{n} \beta_{kl} \ln(X_k) \ln(X_l) + \epsilon$. The Cobb-Douglas function is a special case of this more flexible form when $\beta_{kl} = 0$.

are equal to 10.65 and 13.2 respectively with p-values equal to zeros in both cases).[25] The results reveal that some inputs exhibit non-separability (e.g., adult labour and seeds or fertilisers expenditures). However, we will show that the estimated marginal products of family labour are almost invariant to the choice of the functional form.

Finally, as mentioned earlier, there might be a potential endogeneity problem as there may be unobservable characteristics correlated with both inputs and the output measures. Hence the OLS estimates could be biased. For example, managerial ability which is unobserved (though partly captured by the education of the household head) should be positively correlated with expenditures on seeds. More able farmers would be more favourable in using improved seeds which may increase expenditure on them. At the same time, higher ability may be also associated with greater production. The estimates from OLS would then potentially be biased upward. One may also think that an improved managerial ability of farmers may favour the mechanisation of the farm which would reduce the use of labour inputs. If ability and labour inputs are negatively correlated and if we anticipate the coefficient on the omitted variable to be positive, the OLS estimates would be downwardly biased. Therefore, in order to account for this potential endogeneity problem, IV estimation should be performed. We assume land, farm equipments, the share of irrigated land and other expenses such as those for livestock production (e.g., value of animals used for traction) as exogenous as the time horizon we are considering is one agricultural year during which substantial changes to these types of inputs should be either small or non-existent. Therefore, the instrumented variables should be all the labour inputs (i.e., adult, child, hired and exchange labour), seeds and fertilisers. However, as the data do not offer a relevant natural experiment, we acknowledge the difficulty

[25] A formal test of separability between inputs would imply imposing restrictions sequentially as long as separability is not rejected to obtain a more parsimonious specification (Jacoby, 1993). However, while acknowledging the appropriateness of this test we are not performing it as it is out of scope for the present analysis.

in finding valid instruments for all these potential endogenous regressors. We nonetheless performed an IV estimation which we discuss in the Appendix and report the results in Tables 1.A.1 and 1.A.2. We partly follow, in the choice of the instruments, the existing literature (Abdulai and Regmi, 2000; Jacoby, 1993; Skoufias, 1994). The results show some differences between OLS and IV estimates which may suggest that the problematic variables are indeed endogenous. However, this difference may come from the fact that the instruments are not valid. For this reason IV estimates are as likely to produce biased estimates as OLS ones. Although we do not deny a potential endogeneity problem, given the available data and current setting, we opt for focusing our attention on OLS estimates only.

1.7.2 Marginal product estimates

The estimated production functions allow us to calculate the marginal products of labour inputs for each farm household. In particular we have calculated the marginal product of labour from the Cobb-Douglas production function estimates in the following way:

$$\hat{MRP}_{L_{h,j}} = \hat{\gamma}_j \frac{\hat{Y}_h}{L_{h,j}} \tag{1.26}$$

where $L_{h,j}$ are total hours worked on the farm h by each type of labour input j and $\hat{\gamma}_j$ are the estimated coefficients from the Cobb-Douglas production function on $ln(L_{h,j})$; $\hat{Y}_h$ is the predicted output value for the farm h. Similarly, we compute the marginal products from the Translog production function. For this calculation we also need to account for all interaction and squared terms.[26]

We report the estimated marginal products at their mean from the estimated models in Table 1.7. The estimates suggest that the average adult shadow wage ranges between

[26]The general formula is the following: $\hat{MRP}_{L_k} = [\hat{\beta}_k + \sum_{k=1}^{n}\sum_{l=1}^{n}\hat{\beta}_{kl}\overline{\ln(L_l)}]\frac{\hat{Y}}{L_k}$, where L_k and L_l are the labour inputs.

3.2 and 3.5 rupees per hour. These values are quite similar when estimated using different production technologies. The prevailing rural agricultural wage in Nepal in 2003/04 was around 55 rupees per day (CBS, 2006, 2005). In addition, in 2003 the government of Nepal fixed a minimum wage for agricultural workers equal to 60 Nepalese rupees per day (i.e., Nrs. 7.50 per hour if we assume eight hours of work per day) (Wily et al., 2008). This suggests that the average hourly adult shadow wage is less than half the minimum wage paid to agricultural workers. Part of the previous literature that estimated adult shadow wages, have tested for the equality between marginal products and observed wages. They suggest that any differences between these two measures should shed light on imperfections in the rural labour market, on the presence of transaction costs and other frictions in the markets (Barrett et al., 2008; Jacoby, 1993; Skoufias, 1994). We do not perform this test as we do not have reliable data on the rural market wage.[27] However, the observed difference between the two values may indeed reflect imperfections in the labour market.

A child's shadow wage ranges between an average of 1.6 and 1.7 rupees per hour.[28] If we consider that the average total annual hours worked by a child aged between five and 14 years in our sample of farm households is 750 hours (see table 1.3), the annual average contribution of children appears to be 1,200 rupees. The average annual nominal per capita expenditure of a household is 12,800 rupees. This suggests that child labour contributes, on average, to about the nine percent of it. In addition, the estimated average poverty line in current prices for 2003/04 is 7,695 rupees per person per year (CBS, 2005). This suggests that children's contribution may be, on average, the 15 percent of the annual expenditures of households who are close to the poverty line. Therefore, these estimates suggest a not negligible contribution of child labour to the income of their families.

Moreover, the hourly contribution of child labour is nearly half of those of adults.

[27] This is also one of the reason we need to estimate the shadow wage.

[28] As mentioned earlier we are not including the child marginal product estimated from the Translog 1 specification as there are too many violations of positive and diminishing marginal products.

This also suggests for a quite substantial contribution of child labour to the household income. This ratio between child and adult productivity is consistent with Menon et al. (2005) findings. They estimate a child-adult shadow wage ratio between one-third (when estimating shadow wages from the primal side) and two-third (when estimating shadow wages from the dual side). The difference between child and adult shadow wages suggests that these two types of labour, as expected, are not perfect substitutes given the heterogeneity in their skills. Different productivities of child and adult family labour can be also attributed to the fact that children and adults may be involved in different tasks which ultimately reflect into the output (Menon et al., 2005). As mentioned already, we do not have information on which specific tasks each labourer perform on the farm. For the same reason, we are not able to calculate the different productivity of each labourer on plots under different mode of land operation (e.g., sharecropping).

1.8 Empirical analysis: the labour supply

We now estimate a reduced form model to see whether there is any relation between land and child labour in the sample of farm households. This analysis also serves as a basis to proceed with the estimation of a structural labour supply, which includes shadow wages and shadow income estimates obtained from the production function.

1.8.1 Reduced form estimates

This analysis provides a reduced form estimate to test the poverty hypothesis. A rejection of this hypothesis may lead us to conclude that reasons other than poverty (i.e., imperfections in the labour market) may determine child labour in this setting.

We estimate the following reduced form child labour equation:

$$ln(h_{ih}) = \alpha_0 + \sum_{k=1}^{f} \beta_k A_{h,k} + \sum_{j=1}^{n} \gamma_j Z_{h,j} + \sum_{s=1}^{m} \delta_s X_{ih,s} + \epsilon_{ih} \tag{1.27}$$

where h_{ih} are the total hours worked in the past 12 months by child i, aged between five and 14 years, of household h . The term $A_{h,k}$ refers to land size and other variables k related to land characteristics of household h. Specifically, we include in the specification the hectares of land and its square to allow for non linearity in the relationship. As mentioned already, we also include the number of plots cultivated which, when controlling for hectares of land operated, should inform on the effects of the subdvision of land (Bhalotra and Heady, 2003). We also include a variable which accounts for the fact that some households do not own the land they cultivate, and others both own the land and also cultivate someone else's land (sharecropping). As an alternative to the hectares of land variable as a continuous measure, we also estimate a specification that includes a categorical variable for land size. Finally, $Z_{h,j}$ are characteristics j of household h and $X_{ih,s}$ are characteristics s of child i in household h.

Table 1.8 shows the results from the reduced form estimates. We note in Column 1 that the coefficient on the land size variable is negative and significant. Instead the square of land size is not significant. This suggests a linear relationship between child work and land, contrary to what found in Basu et al. (2010). In addition, these results do not suggest the presence of a 'wealth paradox' as in Bhalotra and Heady (2003). On the contrary, the negative sign seems to indicate that the wealth effect is prevailing over the substitution effect that an increase in land size entails. It seems that children in households which own an increasing amount of land tend to work less on average. In particular, a one hectare increase in land size, reduces child labour by 14 percent.[29] This declining pattern is consistent with the descriptive statistics shown in the first column of Table 1.4 and with poverty being the main cause of child labour (Basu and Van, 1998). As soon as households become richer, child labour decreases. As mentioned already, the existing

[29] We ran the same estimation using the logarithm of land in place of the actual value. We find that a one percent increase in hectares of land, increases child labour by 0.06 percent, which is a quite sizeable effect.

literature suggests that in the presence of perfect labour markets, child labour may emerge only if households are poor (Basu et al., 2010; Dumas, 2007).

However, part of our discussion in previous sections, suggested that the rural labour market in Nepal may not be perfect. Therefore, despite the fact that the wealth effect seems to dominate the substitution effect generated by an increase in land size, part of this latter effect may still be at play. In Column 2 of Table 1.8 we report results that include, in place of the hectares of land cultivated, a set of dummy variables which divide the hectares of land cultivated between very small, small, medium and large farms. We note that the dummy coefficients on farm size are negative and increasing in farm size. However, only the coefficient on large farm is significant. Children in larger farm households work less relative to those in very small farm households. We know from Table 1.5 that most of the children live in households which own or cultivate relatively small areas. Only the ten percent of children live in households with large farms. Hence, it seems that the reduction in child labour, as land size increases, is confined to a small portion of the households in the sample, specifically at the top-end of the land distribution. These estimates suggest that wealth must be sufficiently high in order to see a reduction in child labour. Therefore, we cannot exclude that imperfections in the labour markets may partly explain the existence of child labour in farm households.

The coefficient on the number of plots is positive and significant. This is suggestive of the fact that after controlling for farm size, an increasing number of plots cultivated increases child work which, as mentioned above, may reflect the subdivision of land. When more plots are available for cultivation in the same farm, more children may be needed. This also emerged in the descriptive statistics from table 1.1. Finally, children in households which only cultivate someone else's land relative to those that own the cultivated land tend to work longer hours. This represents a quite small percentage in the sample. Children of households which both own and cultivate others' land relative to those that

only own the land tend to work less hours. This result, controlling for farm size and for the number of plots, may reflect attitudes of parents who can be reluctant to put their children into work on someone else's land.

The signs on the other coefficients in Table 1.8 are mostly in the anticipated direction. Being male decreases on average child hours worked by 34 percent relative to being a female. This substantial change is a reflection of the fact that the total hours worked include housework and other household related activities (e.g., fetching water, collecting firewood) in which girls are typically more involved than boys. As anticipated, older children work more hours. This reflects either an increase in children's productivity as they get older or parents' preferences which may do not favour child labour of very young children (Dumas, 2007). Children of muslim or other religious minorities and of low caste tend to work longer hours than those from higher caste groups. As expected a higher education of the head of the household is negatively related to child hours worked. In addition, subistence households seem to have children working less hours then non-subsistence ones. Since subsistence households are the poorest in our sample, this result, when controlling for farm size, is quite interesting as it may reflect characteristics other than poverty.

In order to further explore these results, we provide in Table 1.9 reduced form estimates with a split of the sample between those who own land and those who own and cultivate others' land.[30] Separate estimates for the sample of households who both own and sharecrop land should reflect mostly a substitution effect (i.e., the opportunity of land) rather than a wealth effect (Bhalotra and Heady, 2003). Interesting results emerge from this analysis which are also consistent with the descriptive statistics provided in table 1.4. Indeed, the results indicate that in households which own land only, child labour is

[30] We do not show the estimates for children in households which only cultivate someone else's land as the sample is very small (100 observations). The results do not show any significant effect on the land variables and are available upon request.

decreasing in farm size. We note that the coefficient on the square of hectares of land is positive and becomes significant. This result may suggest a U-shaped relationship. However, the turning point is at 5.13 hectares which corresponds to very big farms representing only a few households (these households are at the very top end of the distribution, corresponding to the 99th percentile). Therefore, the relationship is still linear for most of the land distribution. For those households that both own and cultivate others' land the sign on land size is now positive and its square is negative. However, despite these signs are consistent with the descriptive statistics provided in table 1.4 and with the inverted-U hypothesis, these coefficients are not significant.

We have estimated separate equations for boys and girls to see if there is any differential effect between them. The results in Table 1.10 reveal that only girls' work is significantly reduced by an increase in land size.[31] We note that the squared term of land hectares is now significant at the 10 percent level but the turning point is still at very big farm size levels.

In order to further shed light on these results we have also estimated the same reduced form model excluding the housework activity (which includes household chores and other activities such as fetching water and firewood collection).[32] The results show that the coefficient on land size is not significant. This may suggest that most of the effect we see in Table 1.8 comes from children's involvement in housework activity. This result is consistent with the fact that we only find significant results on girls and not on boys in the estimates of Table 1.10. Indeed, as girls are typically involved in these types of activities we expected most of the effect shown above to be related to girls.

As a final step of the reduced form analysis we try to account for the fact that hours

[31] In order to test whether the two models are significantly different we have estimated a fully interactive model and the results reveal significantly different effects between boys and girls. The F-statistic is 2.33 (p-value=0.0009).

[32] These results are not reported and are available upon request.

are only observed for children that work. Hence we estimate a Heckman two step model involving a participation and an hours equation. This allows correcting for selectivity (i.e., to check whether the sample of children working some positive hours is randomly drawn from the population). In order to test for this we need to include in the selection equation exogenous variables which are then excluded from the hours equation. However, it is difficult to find variables which shift the participation probability while not directly affecting the hours worked. We select the variables among those that do not appear to affect the hours worked while affecting participation and viceversa. Specifically, the number of persons aged above five and the number of persons aged between 15 and 60 who work only off-farm, are assumed to affect only participation into work. These variables are all likely to affect the work participation of children and not the intensity of their work activity. The hectares of land cultivated and its square are assumed to affect only the hours worked. Subsistence households are also assumed to affect the hours worked and not participation into work. The estimates reported in Table 1.A.3 in the Appendix show that the selection term (i.e., the mills ratio) is positive and significant, suggesting that the correlation between the unobservables that determine the work participation equation and the hours equation is positive. Despite the significance of the selection term, we note that the coefficients on land size have the same signs and similar magnitudes to those of table 1.8, hence reassuring on the results obtained in the reduced form equation. Interestingly, we note that the coefficient on whether households own and cultivate others' land is now positive and significant in the participation equation. This may indicate that, children in households which do not own all the operated land are more likely to work relative to those that own land only. However, they tend to work less hours.

1.8.2 Structural equation estimates

We now provide estimates of the structural labour supply for children 5-14 years old for the same sample of households used for the production function estimate. We estimate the following equation:

$$ln(h_{ih}) = \alpha_0 + \beta_a ln(\widehat{w}_{h,a}) + \beta_c ln(\widehat{w}_{h,c}) + \beta_h ln(\widehat{V}_h) + \sum_{j=1}^{n} \gamma_j Z_{h,j} + \sum_{s=1}^{m} \delta_s X_{ih,s} + \epsilon_{ih} \quad (1.28)$$

where h_{ih} are the total hours worked in the past 12 months by child i aged between five and 14 years of household h; $\widehat{w}_{h,a}$, $\widehat{w}_{h,c}$ and $\widehat{V}_h$ are respectively shadow wages for adult a, child c of household h and shadow income of household h estimated from the production function. As child shadow wage is only available for those households which employ children on the farm, the sample of working children we consider for the structural labour supply estimation is lower than the one used for reduced form estimation. Therefore, the sample includes 1,496 children aged 5-14 who have worked some positive hours in the past 12 months. The terms $Z_{h,j}$ and $X_{ih,s}$ are defined as in equation (1.27).

We conduct this estimate to obtain direct child wage and income elasticities to establish the relative strength of income and substitution effect, hence to quantify the relative role of poverty or of imperfections in the labour market in driving child labour supply.

Table 1.11 reports the OLS estimates which use estimated shadow wages and income from both the Cobb-Douglas and the Translog production technology of child labour supply for those children that work.[33] We note that the estimates in column 1 and 2 are very similar, hence we restrict our comments to those in column 1. The uncompensated wage elasticity (i.e., the coefficient on the child shadow wage) is significant and yields a

[33] In order to account for censorship in the hours worked, we have estimated a Heckman two step model. Similarly to the reduced form estimates, we have used as identifying variables those that do not appear to affect the participation equation but that influence only the hours equation and viceversa. Despite the fact that the estimates show a positive and significant selection term, the results are invariant to a selection bias. The results are not reported but are available upon request.

negative sign. This may suggest the existence of a backward bending labour supply curve where for higher wages, the income effect prevails over the substitution effect. The income elasticity is significant and positive. We have calculated the compensated wage effect from these two coefficients as expressed in the Slutzky equation (i.e., equation (1.21) in Section 1.3) and following Jacoby (1993). The first term on the right hand side of the equation represents the substitution effect which we calculate from the estimated terms above. In particular, as the variables required for this calculation are in logarithm form, we calculate the uncompensated child wage effect multiplying the wage elasticity by the ratio between the average hours worked by children and the sample mean of the child shadow wage. The results indicate that the compensated wage effect is negative and the income effect is positive. These signs are opposite to the theoretical priors and to results obtained in the related literature which estimate adult labour supply using estimated shadow wages and income. The negative sign on the child shadow wage is invariant to the underlying production technology estimates we use. The sign is also consistent across different model specifications.[34] Indeed, we included the logarithm of per capita expenditures in place of the shadow income. The sign on the expenditure coefficient remains positive and significant and the one on the child shadow wage remains significant and negative. We estimate the same model splitting the sample between boys and girls. The signs on the shadow wage and income coefficients are robust to all of these alternatives.

The adult shadow wage seems to affect child labour supply positively. We would expect though a negative sign on this coefficient. We have calculated the compensated cross-wage effect and it is positive. However, this result may suggest that adult and child labour are complementary rather than substitutes. Interestingly, we find that the coefficient on the education of the household head, which was negative and significant in the reduced form

[34]Results not shown but available upon request.

estimates, is statistically insignificant in these results. This may suggest that part of the variation in this variable is captured by the shadow terms which partly reflect farm productivity. The coefficient on the number of children aged between five and 14 is now significant and negative. This result, while controlling for the opportunity cost of labour, suggests that each additional child reduces the hours worked by another child.

1.9 Discussion of the results

The estimates of the child shadow wage suggest that a child's contribution to the family income is not negligible. In particular, on average children's contribute to about the nine percent of the annual average per capita household expenditure. In addition, children's contribution is about half of adults one. This suggests that, in some households, child labour may be necessary to meet their subsistence needs.

The results on the estimated child labour supplies provide insights on whether poverty or imperfections in the labour markets explain child labour in farm households. The reduced form estimates reveal that hours worked by children are decreasing in land size. The work opportunities stemming from land do not seem to be predominant. In particular, girls' work seems to decline as household's wealth increases. However, the same reduction does not appear on boys' labour supply as the coefficients on land size are not significantly different from zero. This result is opposite to what Bhalotra and Heady (2003) find. They show that the substitution effect prevails over the wealth effect of an increase in land size for girls but not for boys. Girls in land-rich households are found to work more than in land poorer households. Their finding suggests that households using girls on the farm are not compelled to do so for poverty reasons but for imperfections in land and labour markets. One explanation for our different results is that our measure of work includes all types of work children can do, while Bhalotra and Heady (2003) look only at on-farm child work. We have shown indeed that the result is significant for girls and driven by

domestic work. As girls are typically more involved in these types of activities this may explain why the results are stronger when including domestic work. As soon as wealth is sufficiently high, households tend to substitute their girls work with hired labour for domestic work. These girls may be put back into school (Basu, 1999).

Therefore, our reduced form results are not suggestive of a 'wealth paradox'. As land increases, child labour decreases. This is consistent with perfect labour markets, where hiring labour becomes easier or where outside work opportunities are higher (Basu et al., 2010). However, the reduction in child labour as land increases, is mostly related to households with sufficiently high wealth. In accordance with our results, Basu et al. (2010) find that a smaller portion of households face the declining part of the inverted-U relationship as the turning point is at high levels of land size. In addition, we see that the negative effect of an increase in land size on child labour supply is related mostly to households which own land only. On the contrary, we do not find any significant effect for households which both own and sharecrop land although the descriptive statistics related to these households implied an inverted-U relationship.

Therefore, we may advance the argument that imperfections in the Nepalese labour market may partly explain the existence of child labour in farm households. Part of our descriptive analysis suggested that rural labour markets in Nepal seem to be imperfect. The prevalence of exchange labour over hired labour was an indication in this sense (Dumas, 2007). As discussed earlier, the increase in agricultural wages and the raising opportunities outside Nepal may have rendered difficult hiring labour. Farm households who need extra-labour may substitute with child or exchange labour for hired labour. However, the labour market seems to function adequately for households at the top-end distribution of land ownership. We may suppose that these households can more easily hire labour.

The convenience of a reduced form approach lies in the fact that it does not include estimated values which may bias the estimates. Of course the drawback of this strategy is

that results are more difficult to interpret given that we are not able to quantify the income and substitution effects. The negative coefficient on the land size variable just suggests that the income effect prevails over the substitution effect resulting from a change in land. We estimate a structural labour supply equation for this purpose. However, as noted, the results on the wage and income elasticities are in contrast with our theoretical priors. We offer some potential explanations for these results. First, despite the empirical strategy we are following should allow us to disentangle income and substitution effects from our estimates, its complexity may instead prevent us from doing so. Hence, the negative sign on the wage elasticity may reflect a prevailing income effect over the substitution effect as in Bhalotra (2007). This could be reconciled with the reduced form results and would suggest a backward bending labour supply curve. A negative coefficient on wage was found also on the female labour supply in Skoufias (1994).[35] They provide as a potential explanation the fact that as the dependent variable (i.e., the hours worked) includes all types of work activities (including domestic work), this negative sign can be a reflection of the broader measure of work used. The positive income elasticity instead may imply that child leisure is an inferior good. This result is in contrast with some of the related literature which instead finds a negative income effect (Abdulai and Regmi, 2000; Jacoby, 1993; Skoufias, 1994) with the exception of Barrett et al. (2008) which also find a positive income effect. In addition, leisure being an inferior good in this type of setting may not be very plausible if we think that child leisure may also include schooling, which is very likely to increase if income increases.

Second, the negative sign on the wage elasticity may also be explained by the fact that our shadow wage measure does not correct for imperfections in the markets and in general for allocative inefficiencies. Barrett et al. (2008) find a similar negative wage

[35] Barrett et al. (2008) also find a negative wage elasticity but only in the estimates that do not correct for allocative inefficiencies.

elasticity in a model which do not control for allocative inefficiencies. Once correcting for allocative inefficiency, the wage elasticity becomes positive, which is consistent with a positively sloped labour supply.[36] We already expressed our motivation for not pursuing this correction but concede that our estimated measures may reflect this.

Third, the conflicting signs on the shadow wage and shadow income coefficients may also be due to the fact that we are not able to address adequately the endogeneity of these variables, hence leading to biased estimates. As explained, the estimated shadow wages and income are endogenous measures. Indeed the estimated marginal products depend on their actual hours of work (Skoufias, 1994). Hence we also estimate our model using instrumental variables. It is difficult to find valid and relevant instruments for shadow wage and income measures. We therefore provide a discussion of IV estimates and related tables in the Appendix (tables 1.A.4 and 1.A.5). Importantly, the results obtained reveal that the coefficient on the child shadow wage, despite of lower magnitude is still negative. This may suggest that this effect is quite robust across different estimation methods.

Finally, this empirical strategy and the related estimates reflect the complex forces that drive labour supply decisions within agricultural households. The fact that the shadow wage and income are estimated measures may create some measurement error in these variables which then reflects into the labour supply estimates (Baland et al., 2010b). This complex structural approach may also suggest that the predictions of the underlying neoclassical model may be violated in a context where the presence of social norms and of informal institutions is important.

[36] Barrett et al. (2008) implement this correction by first testing for the equality between the estimated marginal product and the market wage. Any deviation from this equality informs on the presence of allocative inefficiencies. They then investigate the determinants of these estimated allocative inefficiencies and use the imputed values to provide a shadow wage measure corrected for allocative inefficiencies.

1.10 Concluding remarks

This chapter estimates the contribution of child labour to the family farm and test whether poverty is the main driver of child labour in a sample of agricultural households in rural Nepal. In particular, we analyse child labour in agricultural households where typically consumption and production decisions are jointly determined. Child labour supply in this type of households is the result of complex forces. We first obtain estimates of shadow wages for family labour from the estimate of a farm production function. We then analyse individual child labour supply, estimating both a reduced form and a structural equation which includes the estimated shadow wages and income.

As wages are not available for adults and children who work as self-employed on the farm, shadow wages have to be computed from production function estimates. The shadow wage measures the opportunity cost of time of both children and adults who work on the farm and its estimation allows us to assess the contribution of child and adult family labour to the farm. We find that adult shadow wage is below the minimum agricultural wage which is suggestive of the existence of frictions or imperfections in the Nepalese rural labour market. Most importantly, we find that the estimated child shadow wage is nearly a half of the adult shadow wage for on-farm work and that children contribute on average to the nine percent of the average annual household expenditures. This suggests that the relative contribution of child labour to the income of farm households in Nepal is not negligible. Part of these households may therefore need their children's work purely for their subsistence.

We therefore estimate the child labour supply in farm households to see how it reacts to changing economic conditions and in particular to explore whether child labour is driven mostly by poverty or other reasons such as imperfections in the labour market. We first estimate a reduced form model which includes, as a measure of wealth and work opportunity, the amount of land a household owns or cultivates for someone else (or both).

We find that child labour is decreasing in land size. This result is consistent with poverty-induced child labour in the presence of well-functioning labour markets. The results also show that this effect is mostly driven by households who own land and do not sharecrop, and mostly related to girls. However, we also note that the decline in child labour only occurs for quite large farm size. These results suggest that child labour in farm households declines if wealth is sufficiently high. For these households it may be easier to substitute their girls' domestic work with hired labour. On the contrary, imperfections in the labour market may explain child labour of boys and of a large portion of households which are not at the top-end of the land distribution.

With the reduced form results we are not able to separately quantify the income and substitution effects that an increase in land size generates. The estimates of a structural labour supply model should have allowed us to do so. The coefficient on the child shadow wage elasticity is negative and on the shadow income is positive. These signs are opposite to our theoretical priors. We offered some explanations for these counter-intuitive results.

In spite of the above, the current analysis makes a number of important contributions. First, it is one of the few studies that attempts to estimate the shadow wage of children. We try to assess the monetary contribution of children to the family income in a setting where wages are not available. More specifically, it is the first study which estimates shadow wages for children in farm households of Nepal using data from the 2004 NLSS survey (Menon et al. (2005) used 1996 NLSS survey data). Second, it is also the first study that uses the estimated shadow wages and income in a structural child labour supply equation in order to assess the extent of income and substitution effects to understand the role of poverty. These structural form estimation methods, despite providing theoretical soundness, should be estimated carefully. Given the complexities behind a farm household's decision making process and the specific setting under analysis, the appropriateness of this empirical methodology and of the underlying predictions of the neoclassical

model needs to be reconsidered. Finally, we provide reduced form estimates of child labour for a sample of agricultural households that offer very interesting results. In particular, imperfections in the labour market appear to be a potential cause of child labour in farm households, particularly of boys and of households that also sharecrop others' land. These results highlight both the different roles that boys and girls play within the household and the effects that different modes of operation of land may have on child labour.

This study offers important insights from a policy perspective. The knowledge of the monetary contribution of child labour to the family income may help defining the appropriate amount of cash transfers to households which need their children's work in order to meet their subsistence needs. In addition, the above results also suggest that interventions devoted to the removal of imperfections in the labour markets may be helpful in reducing child labour of boys and in households that are not at the top-end distribution of land. Finally, programmes devoted to the reduction of child labour in agricultural households should also target differently farm households which have different modes of operation of land.

Tables

Table 1.1: Household and farm characteristics in households with working and not working children on the farm

	Farm HH without working children	Farm HH with working children	Diff.
Output	35808.295	36777.606	-969.311
Land (ha)	0.906	0.911	-0.004
Adult labour	3268.610	3709.946	-441.336***
Child labour	0.000	848.122	-848.122***
Hired labour	147.123	107.257	39.866*
Exchange labour	109.049	170.033	-60.983***
Seeds	295.533	214.839	80.693
Fertilisers	1327.777	1366.957	-39.179
Equipment	4471.287	3652.366	818.921
Other expenditures	1882.008	1587.058	294.951
Share of irrigated Land	0.453	0.432	0.021
Share of dry land sharecropped out	0.039	0.027	0.011
Share of wet land sharecropped out	0.043	0.031	0.012
Share of dry land left fallow	0.155	0.138	0.016
Share of wet land left fallow	0.019	0.018	0.001
Share of land sharecropped in	0.166	0.189	-0.023
West Mountains/Hills	0.296	0.280	0.016
East Tarai	0.155	0.142	0.013
West Tarai	0.267	0.231	0.036
HH head has primary education	0.170	0.197	-0.027
HH head has secondary/higher education	0.218	0.144	0.074***
Spring	0.140	0.150	-0.010
Summer	0.360	0.387	-0.026
Autumn	0.140	0.170	-0.030*
Very small farms (below 0.2 ha)	0.167	0.102	0.064***
Small farms (between 0.2 and 1 ha)	0.546	0.571	-0.025
Medium farms (between 1 and 2 ha)	0.194	0.238	-0.044*
Large farms (above 2 ha)	0.093	0.089	0.004
Number of plots	3.388	3.868	-0.480***
Household size	4.975	6.307	-1.332***
Nominal PC consumption	14166.320	10744.821	3421.499***
Subsistence households	0.464	0.454	0.010
Observations	1483	921	

Notes: Author's computations using 2004 NLSS survey; * p<0.10, ** p<0.05, *** p<0.01.

Table 1.2: Descriptive statistics of variables in production function

	Mean	St.Dev.	Min	Max
Output	36179.65	45068.31	76	958034
Land (ha)	0.91	1.13	0	20
Adult labour	3437.69	2439.00	12	20790
Child labour	324.93	686.49	0	6480
Hired labour	131.85	422.49	0	14728
Exchange labour	132.41	220.45	0	4000
Seeds	264.62	1186.26	0	44800
Fertilisers	1342.79	2718.54	0	48000
Equipment	4157.55	28564.50	0	630100
Other expenditures	1769.01	5121.29	0	149200
Share of irrigated Land	0.44	0.40	0	1
Share of dry land sharecropped out	0.03	0.15	0	1
Share of wet land sharecropped out	0.04	0.16	0	1
Share of dry land left fallow	0.15	0.28	0	1
Share of wet land left fallow	0.02	0.09	0	1
Share of land sharecropped in	0.18	0.31	0	1
West Mountains/Hills	0.29	0.45	0	1
East Mountains/Hills	0.31	0.46	0	1
East Tarai	0.15	0.36	0	1
West Tarai	0.25	0.44	0	1
Head has no education	0.63	0.48	0	1
Head has primary education	0.18	0.38	0	1
Head has secondary/higher education	0.19	0.39	0	1
Spring	0.14	0.35	0	1
Summer	0.37	0.48	0	1
Autumn	0.15	0.36	0	1
Winter	0.33	0.47	0	1
Observations	2404			

Notes: Author's computations using 2004 NLSS survey.

Table 1.3: Descriptive statistics on the sample of children 5-14 year old

	All	Boys	Girls
Panel A: Participation rates			
Never attended school	0.21	0.16	0.26
Attended school	0.03	0.04	0.03
Attending school	0.76	0.81	0.70
Idle	0.10	0.10	0.11
Work and school	0.31	0.29	0.33
Work only	0.14	0.09	0.19
School only	0.45	0.52	0.38
Do not work	0.50	0.56	0.44
Work in farm self-employment	0.37	0.37	0.36
Work in other activities	0.13	0.07	0.20
Obs.	3564	1811	1753
Panel B: Working children 5-14			
Total hours worked in past 12 months	754.65	618.61	865.12
Obs.	1774	795	979

Notes: Author's computations using 2004 NLSS survey.

Table 1.4: Children total hours worked in the past 12 months and farm size

	All	Own land	Own and Cultivate others' land	Cultivate other's land
Farm size				
Very small	841.411	893.306	460.346	936.375
Small	769.352	786.816	672.79	984.073
Medium	707.125	701.185	702.548	811.5
Large	682.407	738.176	567.27	1174.571
Total	754.648	779.401	655.455	953.292
Obs.	1774	1165	503	106

Notes: Author's computations using 2004 NLSS survey. Sample includes children 5-14 years old from farm households which work some positive hours in past 12 months.

Table 1.5: Descriptive statistics of variables in child labour supply

	Mean	St.Dev
Total hours worked by children 5-14 in past 12 months	754.65	755.69
Land hectares	0.93	1.01
Land hectares squared	1.89	7.82
Number of plots	3.87	2.86
Very small farms (below 0.2 ha)	0.11	0.31
Small farms (between 0.2 and 1 ha)	0.56	0.50
Medium farms (between 1 and 2 ha)	0.23	0.42
Large farms (above 2 ha)	0.10	0.30
Own land	0.66	0.47
Cultivate others land	0.06	0.24
Own and cultivate others land	0.28	0.45
Child is male	0.45	0.50
Child age	10.91	2.31
West Mountains/Hills	0.27	0.44
East Mountains/Hills	0.36	0.48
West Tarai	0.14	0.35
East Tarai	0.23	0.42
Upper caste	0.45	0.50
Low caste	0.50	0.50
Muslim and other minorities	0.05	0.21
Head has no education	0.64	0.48
Head has primary education	0.20	0.40
Head has secondary education	0.16	0.36
Head age	43.83	11.25
Head is chronic ill	0.11	0.31
Head migrated	0.36	0.48
Number of children 0 to 4	0.75	0.87
Number of children 5 to 14	2.69	1.23
Number of adults older than 60	0.32	0.58
Number of adults older than 14 working off-farm	5.13	2.41
Subsistence households	0.46	0.50
Observations	1774	

Notes: Author's computations using 2004 NLSS survey. Sample includes children 5-14 years old in farm households which work some positive hours in past 12 months.

Table 1.6: Production function estimates

	(1) Cobb-Douglas	(2) Translog 1	(3) Translog 2
Log Land (ha)	0.402***	0.547***	0.557***
	(0.019)	(0.143)	(0.144)
Log Adult labour	0.279***	-0.109	-0.106
	(0.021)	(0.174)	(0.171)
Log Child labour	0.011***	-0.030	0.012***
	(0.004)	(0.054)	(0.004)
Log Hired labour	0.044***	0.146**	0.153**
	(0.006)	(0.065)	(0.065)
Log Exchange labour	0.015***	0.110	0.098
	(0.006)	(0.068)	(0.067)
Log Seeds	0.025***	0.076*	0.075*
	(0.004)	(0.045)	(0.045)
Log Fertilisers	0.012***	0.040	0.041
	(0.004)	(0.043)	(0.043)
Log Equipment	0.076***	0.076	0.077
	(0.011)	(0.072)	(0.072)
Log Other expenditures	0.041***	-0.004	0.002
	(0.005)	(0.046)	(0.046)
Share of irrigated Land	0.262***	0.233***	0.235***
	(0.033)	(0.032)	(0.032)
Share of dry land sharecropped out	0.003	0.087	0.070
	(0.208)	(0.205)	(0.203)
Share of wet land sharecropped out	-0.809***	-0.806***	-0.798***
	(0.206)	(0.207)	(0.205)
Share of dry land left fallow	-0.214***	-0.181***	-0.193***
	(0.050)	(0.048)	(0.048)
Share of wet land left fallow	-0.438***	-0.418***	-0.416***
	(0.146)	(0.146)	(0.146)
Share of land sharecropped in	-0.134***	-0.095**	-0.092**
	(0.040)	(0.039)	(0.039)
West Mountains/Hills	0.141***	0.182***	0.187***
	(0.031)	(0.031)	(0.032)
East Tarai	-0.025	-0.007	-0.008
	(0.041)	(0.042)	(0.042)
West Tarai	0.050	0.061*	0.066*
	(0.037)	(0.036)	(0.036)
Head has primary education	0.069**	0.053*	0.051*
	(0.030)	(0.028)	(0.028)
Head has secondary/higher education	0.132***	0.080***	0.080***
	(0.031)	(0.030)	(0.030)
Spring	0.021	-0.028	-0.034
	(0.038)	(0.035)	(0.035)
Summer	-0.014	-0.016	-0.017
	(0.028)	(0.026)	(0.026)
Autumn	0.062*	0.062*	0.068*
	(0.036)	(0.035)	(0.035)
Log Land squared		0.050**	0.050**
		(0.021)	(0.021)
Log Adult labour squared		0.079***	0.078***
		(0.024)	(0.023)
Log Hired labour squared		0.032***	0.031***
		(0.008)	(0.008)
Log Exchange labour squared		0.002	0.003
		(0.008)	(0.007)
Log Seeds squared		0.013**	0.013**
		(0.005)	(0.005)
Log Fertilisers squared		0.033***	0.033***
		(0.004)	(0.004)
Log Equipment squared		0.015***	0.016***
		(0.004)	(0.004)
Log Other expenditures squared		0.020***	0.020***
		(0.003)	(0.003)
Log Adult x Log Seeds		-0.012**	-0.012**
		(0.006)	(0.006)
Log Adult x Log Fertilisers		-0.018***	-0.019***
		(0.006)	(0.006)
Log Child x Log Equipment		0.005*	
		(0.003)	
Log Child x Log Other expenditures		-0.003**	
		(0.001)	
Log Hired x Log Equipment		-0.016***	-0.016***
		(0.003)	(0.003)
Constant	6.958***	7.704***	7.671***
	(0.184)	(0.744)	(0.746)
Obs.	2404	2404	2404
R-squared	0.702	0.739	0.737

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. East Mountains/Hills is the reference category for the regional variables, head has no education for household's head education variables and Winter for the season dummies. Estimates in column 2 and 3 include all interaction terms between the inputs but we only report the significant ones for simplicity. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.7: Marginal product estimates

	Obs.	Cobb-Douglas	Translog 1	Translog 2
Adult	2404	3.24	3.39	3.47
		(3.46)	(7.48)	(7.68)
Children	921	1.58		1.66
		(3.57)		(3.81)

Notes: Author's computations using 2004 NLSS survey. Column two reports marginal products estimated from the Cobb-Douglas production function. Columns three and four refer to marginal products estimated from Translog production functions.

Table 1.8: Child labour supply reduced form estimates

	(1)	(2)
Land hectares	-0.128**	
	(0.060)	
Land hectares squared	0.012	
	(0.007)	
Small farms (between 0.2 and 1 ha)		-0.074
		(0.093)
Medium farms (between 1 and 2 ha)		-0.133
		(0.109)
Large farms (above 2 ha)		-0.291**
		(0.134)
Number of plots	0.026**	0.026**
	(0.011)	(0.011)
Cultivate others land	0.249**	0.247**
	(0.119)	(0.118)
Own and cultivate others land	-0.184***	-0.187***
	(0.064)	(0.065)
Child is male	-0.408***	-0.410***
	(0.053)	(0.054)
Child age	0.115***	0.115***
	(0.012)	(0.012)
East Mountains/Hills	0.006	0.005
	(0.071)	(0.072)
West Tarai	-0.272***	-0.276***
	(0.093)	(0.093)
East Tarai	0.092	0.096
	(0.092)	(0.093)
Low caste	0.203***	0.202***
	(0.056)	(0.056)
Muslim and other minorities	0.481***	0.481***
	(0.138)	(0.137)
Head has primary education	-0.174**	-0.177***
	(0.068)	(0.068)
Head has secondary education	-0.354***	-0.356***
	(0.078)	(0.078)
Head age	-0.006**	-0.007**
	(0.003)	(0.003)
Head is chronic ill	-0.139	-0.140*
	(0.085)	(0.085)
Head migrated	-0.069	-0.071
	(0.057)	(0.057)
Number of children 0 to 4	0.088***	0.087***
	(0.033)	(0.033)
Number of children 5 to 14	0.025	0.026
	(0.022)	(0.022)
Number of adults older than 60	0.011	0.010
	(0.049)	(0.049)
Number of adults older than 14 working off-farm	-0.014	-0.014
	(0.012)	(0.012)
Subsistence households	-0.106*	-0.104*
	(0.060)	(0.060)
Constant	5.319***	5.337***
	(0.212)	(0.227)
Obs.	1774	1774
R-squared	0.123	0.123

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. Sample includes children 5-14 years old from farm households which work some positive hours in past 12 months. Reference categories: very small farms, west mountains/hills, high caste, head has no completed education. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.9: Child labour supply reduced form estimates - Households which sharecrop and do not sharecrop

	(1) Own land	(2) Own land and cultivate others' land	(3) Own land	(4) Own land and cultivate others' land
Land hectares	-0.195**	0.041		
	(0.079)	(0.360)		
Land hectares squared	0.019***	-0.015		
	(0.007)	(0.107)		
Small farms (between 0.2 and 1 ha)			-0.147	0.472
			(0.119)	(0.364)
Medium farms (between 1 and 2 ha)			-0.257*	0.480
			(0.151)	(0.412)
Large farms (above 2 ha)			-0.360*	0.254
			(0.187)	(0.447)
Number of plots	0.012	0.051**	0.011	0.050**
	(0.016)	(0.024)	(0.017)	(0.024)
Child is male	-0.414***	-0.389***	-0.417***	-0.383***
	(0.072)	(0.105)	(0.072)	(0.104)
Child age	0.120***	0.116***	0.119***	0.112***
	(0.015)	(0.025)	(0.015)	(0.026)
East Mountains/Hills	-0.036	0.226	-0.034	0.243
	(0.124)	(0.266)	(0.126)	(0.266)
West Tarai	-0.497***	0.125	-0.503***	0.169
	(0.141)	(0.301)	(0.137)	(0.313)
East Tarai	-0.123	0.590**	-0.125	0.614**
	(0.160)	(0.298)	(0.160)	(0.294)
Low caste	0.206**	0.223*	0.202**	0.221*
	(0.091)	(0.133)	(0.091)	(0.131)
Muslim and other minorities	0.680***	0.405	0.682***	0.383
	(0.205)	(0.315)	(0.202)	(0.313)
Head has primary education	-0.096	-0.317*	-0.103	-0.275
	(0.090)	(0.188)	(0.091)	(0.171)
Head has secondary education	-0.400***	-0.271	-0.395***	-0.275
	(0.111)	(0.199)	(0.115)	(0.195)
Head age	-0.006	-0.012*	-0.007*	-0.012*
	(0.004)	(0.007)	(0.004)	(0.007)
Head is chronic ill	-0.097	-0.056	-0.106	-0.053
	(0.124)	(0.188)	(0.129)	(0.197)
Head migrated	0.009	-0.230	0.007	-0.246*
	(0.096)	(0.146)	(0.096)	(0.143)
Number of children 0 to 4	0.050	0.116	0.047	0.103
	(0.048)	(0.077)	(0.047)	(0.077)
Number of children 5 to 14	0.032	-0.008	0.029	-0.005
	(0.036)	(0.044)	(0.036)	(0.046)
Number of adults older than 60	0.052	-0.011	0.046	0.001
	(0.067)	(0.129)	(0.068)	(0.134)
Number of adults older than 14 working off-farm	-0.018	-0.008	-0.016	-0.007
	(0.020)	(0.026)	(0.020)	(0.026)
Subsistence households	-0.093	-0.098	-0.085	-0.090
	(0.080)	(0.161)	(0.081)	(0.162)
Constant	5.409***	4.926***	5.482***	4.550***
	(0.252)	(0.469)	(0.264)	(0.536)
Obs.	1165	503	1165	503
R-squared	0.132	0.138	0.130	0.148

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. Sample includes children 5-14 years old from farm households which work some positive hours in past 12 months. Reference categories: very small farms, west mountains/hills, high caste, head has no completed education. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.10: Child labour supply reduced form estimates - Boys vs girls

	(1) Boys	(2) Girls	(3) Boys	(4) Girls
Land hectares	-0.073	-0.160**		
	(0.097)	(0.075)		
Land hectares squared	0.005	0.015*		
	(0.010)	(0.009)		
Small farms (between 0.2 and 1 ha)			-0.137	-0.034
			(0.172)	(0.108)
Medium farms (between 1 and 2 ha)			-0.135	-0.166
			(0.191)	(0.134)
Large farms (above 2 ha)			-0.368	-0.221
			(0.234)	(0.162)
Number of plots	0.038**	0.015	0.039**	0.014
	(0.017)	(0.015)	(0.017)	(0.015)
Cultivate others land	0.175	0.317**	0.168	0.314**
	(0.203)	(0.149)	(0.203)	(0.149)
Own and cultivate others land	-0.201**	-0.174**	-0.199**	-0.182**
	(0.101)	(0.084)	(0.100)	(0.084)
Child age	0.094***	0.128***	0.096***	0.128***
	(0.020)	(0.016)	(0.020)	(0.016)
East Mountains/Hills	-0.068	0.054	-0.064	0.057
	(0.113)	(0.093)	(0.113)	(0.094)
West Tarai	-0.186	-0.357***	-0.183	-0.357***
	(0.140)	(0.127)	(0.139)	(0.127)
East Tarai	0.192	0.012	0.192	0.022
	(0.147)	(0.120)	(0.146)	(0.122)
Low caste	0.222***	0.198***	0.221***	0.194**
	(0.085)	(0.076)	(0.085)	(0.076)
Muslim and other minorities	0.607***	0.412**	0.611***	0.408**
	(0.229)	(0.174)	(0.229)	(0.174)
Head has primary education	-0.138	-0.205**	-0.132	-0.215**
	(0.113)	(0.086)	(0.112)	(0.085)
Head has secondary education	-0.368***	-0.355***	-0.369***	-0.356***
	(0.121)	(0.104)	(0.121)	(0.105)
Head age	-0.005	-0.007**	-0.005	-0.008**
	(0.004)	(0.004)	(0.004)	(0.004)
Head is chronic ill	-0.099	-0.187*	-0.101	-0.194*
	(0.134)	(0.109)	(0.134)	(0.110)
Head migrated	-0.216**	0.054	-0.217**	0.053
	(0.090)	(0.074)	(0.090)	(0.074)
Number of children 0 to 4	0.102*	0.066	0.102*	0.063
	(0.055)	(0.041)	(0.054)	(0.041)
Number of children 5 to 14	0.017	0.030	0.022	0.027
	(0.035)	(0.029)	(0.035)	(0.029)
Number of adults older than 60	-0.027	0.051	-0.031	0.047
	(0.074)	(0.065)	(0.074)	(0.066)
Number of adults older than 14 working off-farm	-0.035*	0.005	-0.034*	0.006
	(0.019)	(0.015)	(0.019)	(0.015)
Subsistence households	-0.060	-0.143*	-0.071	-0.134*
	(0.092)	(0.080)	(0.092)	(0.081)
Constant	5.131***	5.188***	5.180***	5.176***
	(0.337)	(0.269)	(0.374)	(0.284)
Obs.	795	979	795	979
R-squared	0.091	0.120	0.094	0.118

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. Sample includes children 5-14 years old from farm households which work some positive hours in past 12 months. Reference categories: very small farms, west mountains/hills, high caste, head has no completed education. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.11: Child labour supply structural form estimates

	(1) OLS from Cobb-Douglas	(2) OLS from Translog
Log Children shadow wage	-0.627***	-0.632***
	(0.021)	(0.021)
Log Adult shadow wage	0.120***	0.124***
	(0.043)	(0.042)
Log Shadow income	0.173***	0.186***
	(0.026)	(0.027)
Child is male	-0.468***	-0.470***
	(0.042)	(0.042)
Child age	0.118***	0.119***
	(0.010)	(0.010)
East Mountains/Hills	-0.044	-0.056
	(0.054)	(0.054)
West Tarai	-0.110	-0.117
	(0.076)	(0.076)
East Tarai	-0.006	-0.030
	(0.065)	(0.064)
Low caste	0.069	0.071
	(0.045)	(0.044)
Muslim and other minorities	0.226*	0.250**
	(0.116)	(0.119)
Head has primary education	0.009	0.007
	(0.056)	(0.055)
Head has secondary education	-0.008	-0.019
	(0.066)	(0.067)
Head age	-0.002	-0.002
	(0.002)	(0.002)
Head is chronic ill	-0.144*	-0.149*
	(0.078)	(0.078)
Head migrated	-0.060	-0.083*
	(0.044)	(0.044)
Number of children 5 to 14	-0.118***	-0.119***
	(0.019)	(0.019)
Number of adults older than 14 working off-farm	0.019**	0.021**
	(0.010)	(0.010)
Number of children 0 to 4	0.077***	0.073***
	(0.026)	(0.026)
Number of adults older than 60	0.062	0.058
	(0.040)	(0.040)
Subsistence households	-0.226***	-0.225***
	(0.047)	(0.046)
Constant	3.099***	3.016***
	(0.295)	(0.307)
Obs.	1496	1496
R-squared	0.523	0.523
Mean dependent variable	791.37	791.37
	(776.42)	(776.42)
Mean adult shadow wage	2.99	2.94
	(2.17)	(2.38)
Mean child shadow wage	1.29	1.34
	(3.04)	(3.16)
Mean shadow income	48453.04	49011.84
	(63021.50)	(63014.39)

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. Sample includes children 5-14 years old from farm households which work some positive hours in past 12 months. Column 1 and column 2 include shadow wages and income measures estimated from Cobb-Douglas and Translog production function estimates respectively. Reference categories: west mountains/hills, high caste, head has no completed education.* p<0.10, ** p<0.05, *** p<0.01.

1.A Appendix

1.A.1 Imputation of missing crop prices

Within our sample there are missing prices for crops which are not sold on the market. Out of 26,893 observations corresponding to quantities of crops harvested by each household there are only 3,416 observations on prices at the household level. Therefore we proceed with imputation of missing prices.

We firstly convert prices and quantities harvested in the same unit of measure using the conversion factors provided in the companion documents of the 2004 NLSS Survey (CBS, 2004). In this way we are able to multiply quantities of crops produced by prices expressed in the same unit of measure to obtain the value of farm production.

The procedure we follow for price imputation is the following. The available prices are either at the household level (i.e., reported by the household who sells its products on the market) or at the ward/community level. We first use household level crop prices when available. When prices are not available for some households, we take the ward level average of prices reported by other households for the same crop in the same ward (these are therefore still prices reported by households). The remaining missing information is then imputed with community level market prices for the same crops. After these imputations we are able to cover the 42 percent of observations for prices. These prices are then used in order to impute the remaining missing observations. We exploit the Hotdeck imputation method procedure whereby missing data are imputed stochastically rather than deterministically (Rubin, 2004; Rubin and Schenker, 1987). For this reason we run the procedure one hundred times. We take the row average over the one hundred prices generated for each crop produced by every household. There will still be some crops for which there are no available prices as no prices have been reported for them. These crops are Sweet Lime, Bamboo and Other Trees. These three crops represent respectively

the 0.1, 0.7 and 0.9 percent of the overall household production. Therefore we believe we are ignoring only a marginal portion of farm production. As a final step we adjust this price measure for regional price differences dividing the prices by its regional price index as reported in the 2004 NLSS Survey data. Finally, we multiply the quantity produced on each crop by its relative price. This is the value of farm production used for our analysis.

As a robustness check we have imputed prices in another way. First, as above we use prices reported at the household level. We then replace the missing observation with the ward level average of prices reported at the household level on the same crops. We replace the missing information with the average prices at the district level, then at the region level and finally at the country level. The output measure we obtain is largely similar to the one obtained above. Hence we use the first measure as output variable.

1.A.2 Instrumental variable estimates of the Cobb-Douglas production function

In the related literature common used instruments for hours worked on the farm by family members are the number of adults and children in the household in different age groups. The rationale behind this is that an additional adult or child in a farm household should increase its number of hours worked on the farm while affecting the farm output only indirectly. Hired and exchange labour are instrumented with variables at the village level. More precisely we use a dummy that says whether there is temporary migration of people in the village that look for work as an instrument for hired labour. We then use the number of landless households in the village that provide labour on other farms and the daily market wage at village level for adults as an instrument for exchange labour.[37] These variables should be all relevant and valid instruments for hired and exchange labour as they

[37] As market wages are only available for some villages, we impute the missing observations with the median wage at the district level, hence reducing substantially their variability.

should capture the supply of these type of labour at the village level while not affecting directly the farm and livestock production. These instruments are a bit less intuitively valid for exchange labour. Indeed this input is driven by forces (e.g. traditions and norms) that cannot be easily captured by the available data. Unfortunately, we do not have data to capture the seasonality in the use of hired and exchange labour. Our conjecture is that this is an important omission for our analysis. Finally, we use available market prices of seeds (i.e., rice seeds) and fertilisers (i.e., urea) at village level and the distance from the closest market for agricultural inputs purchases as instruments for seeds and fertilisers expenditures.

Table 1.A.1 shows the first stage results from regressing each endogenous variable on its set of instruments. We see that the coefficients on the instruments are all significant and show the expected signs. The sign on the coefficient for the number of households in the village without land but that provide labour, is negatively correlated with the exchange labour input. A positive sign would have been more intuitive. The usual F-test that provides information on whether instruments are relevant cannot be applied here as there are multiple endogenous variables. We report the estimates from the two stage least squares model in Table 1.A.2. We note that the coefficient on the land input becomes lower than in OLS estimates and below the coefficient on adult labour which is now substantially increased. This result is less consistent with the literature as land seems to contribute the most to the production. Also the results suggest that the coefficients on child, hired and exchange labour are not significant anymore. The Durbin-Wu-Hausman test shows that we strongly reject the null hypothesis of exogeneity of the instrumented variables, hence suggesting for the need of applying an IV model. However, the Hansen's J statistic which under the null hypothesis tests that all instruments are valid (i.e., test the independence of the selected instruments from the errors in the structural equation) indicate that we reject the overidentifying restriction test for orthogonality of the instruments, hence leading us

to conclude that our instruments are not valid. The difference between OLS and IV estimates may suggest that the problematic variables are indeed endogenous. However, this difference may come from the fact that the instruments are not valid. For this reason IV estimates are as likely to produce biased estimates as OLS ones.

1.A.3 Instrumental variable estimates of the structural child labour supply equation

We use as instrument for the child shadow wage the children market wage at the village level.[38] We also exploit the number of public schools present in the village. The instrument for adult shadow wage is the adult market wage at the village level. Finally, instruments for the shadow income are whether the household has electricity, water and whether the household has a loan. The orthogonality of some of these instruments is questionable as well as the relevance. Table 1.A.4 in the Appendix shows the results from the first stage estimates which regress each endogenous variable on its set of instruments. All coefficients are significant and have the expected signs. The coefficient on the instrument for adult wages is significant at the 10 percent. The usual F-statistics which should inform on the relevance of the instruments does not apply in this setting given that there are multiple endogenous variables. We proceed with the IV estimation and report the estimates in Table 1.A.5 in the Appendix. The Durbin-Wu-Hausman test does not reject the null hypothesis of exogeneity of the instrumented variables. This would suggest that the above variables may not need instrumentation. However, a failure to reject this test may also come from the fact that this model is weakly identified. The Hansen's J statistic which tests for overidentifying restrictions shows that we fail to reject the null hypothesis, hence suggesting that our instrument set is valid. However, the outcome of this test can be

[38] There are missing values for the market wage, so we impute these values with the median level of wage at the district level, hence loosing variability.

fairly misleading if the instruments are not relevant. Notwithstanding these limitations it is interesting to compare this IV results with the OLS results. We note that results in Table 1.A.5 still show a negative coefficient on the shadow wage elasticity. Despite that, its magnitude is lower than in OLS estimates. In addition the coefficients on adult shadow wage and shadow income are not statistically significant. These IV estimates may be as biased as the OLS ones. However, the fact that the coefficient on the child shadow wage, despite of lower magnitude is still negative may suggest that this effect is quite robust across different estimation methods.

Appendix tables

Table 1.A.1: Cobb-Douglas production function IV estimates - First stage

	(1) Adult labour	(2) Child labour	(3) Hired labour	(4) Exchange labour	(5) Seeds	(6) Fertilisers
Number children 15 to 17	0.123***					
	(0.031)					
Number adults 18 to 60	0.120***					
	(0.010)					
Number children 5 to 10		0.768***				
		(0.052)				
Number children 11 to 14		1.498***				
		(0.063)				
Temporary migration in village			0.412***			
			(0.099)			
Number HH with landless labourers in village				-0.014***		
				(0.003)		
Log daily rural adult wage				0.230**		
				(0.110)		
Log village price input seeds (rice)					-0.304***	
					(0.067)	
Log village price input fertilisers (urea)						-1.642***
						(0.261)
Distance from market for agricultural inputs						-0.010***
						(0.004)
Obs.	2404	2404	2404	2404	2404	2404
R-squared	0.427	0.312	0.411	0.322	0.238	0.391

Notes: Author's computations using 2004 NLSS survey. Each model includes also all other explanatory variables included in the second stage. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.A.2: Production function IV estimates

	(1) Cobb-Douglas-IV
Log Land (ha)	0.242***
	(0.084)
Log Adult labour	0.573***
	(0.108)
Log Child labour	0.011
	(0.010)
Log Hired labour	0.076
	(0.072)
Log Exchange labour	0.040
	(0.058)
Log Seeds	0.138**
	(0.055)
Log Fertilisers	0.016
	(0.023)
Log Equipment	0.027
	(0.020)
Log Other expenditures	0.003
	(0.023)
Share of irrigated Land	0.181**
	(0.091)
Share of dry land sharecropped out	0.274
	(0.242)
Share of wet land sharecropped out	-0.560*
	(0.286)
Share of dry land left fallow	-0.169***
	(0.059)
Share of wet land left fallow	-0.339*
	(0.186)
Share of land sharecropped in	-0.101
	(0.065)
West Mountains/Hills	0.221***
	(0.073)
East Tarai	-0.009
	(0.181)
West Tarai	0.070
	(0.133)
HH head has primary education	0.014
	(0.050)
HH head has secondary/higher education	0.034
	(0.095)
Spring	0.028
	(0.057)
Summer	-0.015
	(0.047)
Autumn	0.079*
	(0.044)
Constant	4.669***
	(0.902)
Obs.	2404
R-squared	0.571
Hansen's J statistic	14.237
p-value Hansen's J	(0.007)
Durbin-Wu-Hausman Chi-squared	43.749
p-value DWH	(0.000)

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. Instruments: Number of children 15 to 17, number adults 18 to 60, number children 5 to 10, number children 11 to 14, temporary migration in village, number HH with landless labourers in village, log daily rural adult wage, log village price input seeds, log village price input fertilisers, distance from market for agricultural inputs. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.A.3: Child labour supply reduced form estimates - Heckman two step estimator

	(1)		(2)	
	Hours eq.	Participation eq.	Hours eq.	Participation eq.
Land hectares	-0.139**			
	(0.055)			
Land hectares squared	0.012*			
	(0.006)			
Small farms (between 0.2 and 1 ha)			-0.078	
			(0.088)	
Medium farms (between 1 and 2 ha)			-0.145	
			(0.104)	
Large farms (above 2 ha)			-0.310**	
			(0.129)	
Number of plots	0.030***	0.027***	0.029***	0.027***
	(0.011)	(0.009)	(0.011)	(0.009)
Cultivate others land	0.280**	0.242**	0.276**	0.242**
	(0.124)	(0.114)	(0.124)	(0.114)
Own and cultivate others land	-0.164***	0.115*	-0.167***	0.115*
	(0.063)	(0.059)	(0.063)	(0.059)
Child is male	-0.489***	-0.456***	-0.487***	-0.456***
	(0.066)	(0.050)	(0.066)	(0.050)
Child age	0.172***	0.360***	0.169***	0.360***
	(0.033)	(0.012)	(0.033)	(0.012)
East Mountains/Hills	0.054	0.334***	0.051	0.334***
	(0.076)	(0.068)	(0.076)	(0.068)
West Tarai	-0.311***	-0.175**	-0.314***	-0.175**
	(0.097)	(0.082)	(0.097)	(0.082)
East Tarai	0.069	-0.126*	0.072	-0.126*
	(0.088)	(0.075)	(0.088)	(0.075)
Low caste	0.213***	0.112**	0.211***	0.112**
	(0.058)	(0.054)	(0.058)	(0.054)
Muslim and other minorities	0.459***	-0.118	0.461***	-0.118
	(0.140)	(0.115)	(0.139)	(0.115)
Head has primary education	-0.190***	-0.073	-0.193***	-0.073
	(0.070)	(0.066)	(0.070)	(0.066)
Head has secondary education	-0.434***	-0.425***	-0.433***	-0.425***
	(0.091)	(0.071)	(0.091)	(0.071)
Head age	-0.009***	-0.012***	-0.010***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)
Head is chronic ill	-0.124	0.038	-0.126	0.038
	(0.088)	(0.085)	(0.088)	(0.085)
Head migrated	-0.053	0.052	-0.056	0.052
	(0.057)	(0.054)	(0.057)	(0.054)
Number of children 0 to 4	0.093***	0.063**	0.091***	0.063**
	(0.032)	(0.030)	(0.032)	(0.030)
Subsistence households	-0.100*		-0.098*	
	(0.058)		(0.058)	
Number of children 5 to 10		0.039		0.039
		(0.026)		(0.026)
Number of children 11 to 15		-0.217***		-0.217***
		(0.031)		(0.031)
Number of adults 16 to 17		0.001		0.001
		(0.054)		(0.054)
Number of adults 18 to 60		-0.095***		-0.095***
		(0.022)		(0.022)
Number of adults older than 60		-0.114**		-0.114**
		(0.045)		(0.045)
Number of adults older than 14 working off-farm		0.047***		0.047***
		(0.014)		(0.014)
Constant	4.662***	-2.574***	4.716***	-2.574***
	(0.418)	(0.177)	(0.420)	(0.177)
Mills ratio (lambda)		0.358*		0.342*
		(0.195)		(0.193)
Obs.	1774	3564	1774	3564

Notes: Author's computations using 2004 NLSS survey. Sample includes children 5-14 years old from farm households which work some positive hours in past 12 months. Reference categories: very small farms, household owns land, west mountains/hills, high caste, head has no completed education. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.A.4: Child labour supply IV estimates - First stage

	(1) Child shadow wage	(2) Adult shadow wage	(3) Shadow income
Log rural child market wage	0.413***		
	(0.104)		
Number of public schools	0.031***		
	(0.010)		
Log rural adult market wage		0.066*	
		(0.037)	
HH has piped source of water			8601.598**
			(3692.503)
HH uses electricity as light source			18764.025***
			(4022.879)
HH has a loan			27894.689***
			(3835.408)
Obs.	1496	1496	1496
R-squared	0.271	0.290	0.180

Notes: Author's computations using 2004 NLSS survey. Each model includes also all other explanatory variables included in the second stage. * p<0.10, ** p<0.05, *** p<0.01.

Table 1.A.5: Child labour supply IV estimates

	(1) IV
Log Children shadow wage	-0.470***
	(0.151)
Log Adult shadow wage	-0.219
	(0.368)
Log Shadow income	0.021
	(0.084)
Child is male	-0.462***
	(0.044)
Child age	0.124***
	(0.011)
East Mountains/Hills	-0.110
	(0.073)
West Tarai	-0.147
	(0.100)
East Tarai	0.127
	(0.157)
Low caste	0.058
	(0.053)
Muslim and other minorities	0.291**
	(0.138)
Head has primary education	0.011
	(0.068)
Head has secondary education	0.054
	(0.098)
Head age	-0.004
	(0.003)
Head is chronic ill	-0.107
	(0.081)
Head migrated	-0.026
	(0.048)
Number of children 5 to 15	-0.068
	(0.044)
Number of adults older than 15 working off-farm	0.005
	(0.017)
Number of children 0 to 4	0.069**
	(0.029)
Number of adults older than 60	0.093**
	(0.047)
Subsistence households	-0.306***
	(0.085)
Constant	5.043***
	(1.115)
Obs.	1496
R-squared	0.474
Hansen's J statistic	3.214
p-value Hansen's J	(0.360)
Durbin-Wu-Hausman Chi-squared	4.906
p-value DWH	(0.179)

Notes: Author's computations using 2004 NLSS survey. Robust standard errors in parenthesis. Shadow wages and income measures are estimated from Cobb-Douglas production function estimates. Instruments: child village wage, number of public schools in the village, adult village wage, household has electricity, household has water, household has a loan. * p<0.10, ** p<0.05, *** p<0.01

Chapter 2

Women as decision makers in Community Forest management in Nepal

2.1 Introduction

The management and protection of common property resources such as forests, water or fishing grounds have been central issues in development economic policies in recent years. Increased scarcity of these resources poses serious concerns not only in terms of environmental sustainability but also for rural populations reliant on environmental resources for their livelihoods. Over the few decades local level collective action institutions emerged as ways to protect the resources as well as sustain local development. Over the years these institutions were deemed to be successful for environmental resources protection, though more recent concerns started to emerge on their correct functioning. The existence of socio-economic heterogeneity and gender inequality within community institutions may indeed lead to a failure of collective action mechanisms (Adhikari and Lovett, 2006; Baland et al., 2007).

The purpose of this essay is to analyse whether and how an increased participation of women in the decision-making body of local collective action institutions - the Executive Committee (EC) of Community Forest User Groups (CFUGs) in Nepal - affects forest protection, specifically the quantity of firewood collected by the households. Firewood extraction is considered as one of the main causes of deforestation. Therefore, a reduction in the quantity of firewood collected would imply better forest conditions. Our hypothesis is that a higher female representation in ECs of CFUGs contributes to better forest management and hence to forest protection.

Nepal is a particularly suitable country for this analysis. In 1993 the government of Nepal promulgated a Forest Act which established the transfer of national forests to local communities. Since then Community Forest User Groups (FUGs from now on) have been formed for the management and protection of these forests. These groups can autonomously manage the forests and decide on the distribution of benefits deriving from the forest resources. On the basis of 2010 estimates on the Nepalese forest cover, nearly the 44 percent of forest area in Nepal is now covered by FUGs (FAO, 2010b). The Executive Committee of each FUG plays a critical role in defining the forest products extraction rules and its composition is therefore crucial for the functioning and effectiveness of these institutions. We use two national representative household surveys, the NLSS 2004 and 2011, and combine them with a census of all FUGs formed in the country. This is a unique feature of our analysis.

This study is motivated by the fact that minimal research has been devoted to exploring gender differences within community-based institutions established for natural resources management. However, women are largely responsible for the collection and use of firewood and other forest products within a household. Despite being important stakeholders in forest management, they are often neglected in the decision-making process that sets out the rules to access and collect forest products within a Community Forest (CF). The

recognition of the essential role that women play within community level forest institutions can make a difference in terms of forest conservation and equity in the distribution of benefits.[1]

Why should an increased presence of women in the ECs of FUGs make such a difference? We expect female participation to affect the outcome for one main reason. Women have different and complementary *interests* relative to men within a FUG which stem from the differences in concerns and nature of dependence on forest that women have relative to men (Agarwal, 2000, 2010b). They are the main users of forests, at least of those products which are essential to household daily life. Women have better knowledge than men of certain forest products, on how these products should be extracted and which species should be planted. Given the specific interests of women in certain forest products and particularly in firewood, they thus have the incentive to ensure the availability of these products and ultimately to protect the forests. Women may also have different *preferences* than men (Chattopadhyay and Duflo, 2004). This links to the growing literature on women in leadership positions. They tend to favour redistribution and to support child-related expenditures and outcomes. Women would then have a stronger preference than men to ensure that household's firewood needs are satisfied both in the short and long run.

Therefore, a higher representation of women may increase the effectiveness of FUGs in terms of forest management and protection. However, women face a trade-off as they need to balance sustainable forest protection with their immediate household needs. For the above reasons we argue that, for given forest conditions, women sitting on the ECs may favour decisions that prioritise a sustainable extraction of firewood. We would expect a negative sign on the effect of an increased female participation on firewood collection.

We first look at the determinants of female participation in Executive Committees

[1] We concentrate in the present study only on the analysis of the effects of a higher female participation in the ECs of FUGs on the protection of forests (i.e., on the quantity of firewood collected at the household level).

and then analyse the relationship between such participation and firewood collection. As a further step we also try to account for the potential endogeneity of female participation. Hence we propose one way to address this issue using a difference-in-difference estimation strategy to exogenously identify the effect of an increase in female participation on firewood collection. In 2009 an amendment to the Community Forest programme's operational guidelines sets at 50 percent the minimum threshold for female representation in the ECs of FUGs. This new provision actually increased female participation within these local institutions. We exploit this exogenous variation in the percentage of women in the Executive Committees of groups formed after 2009 and compare the outcome before and after this change, as an identification strategy. The results show that higher female participation in the ECs of FUGs leads to a decrease in firewood extraction. This evidence is suggestive that women are prioritising conservation to ensure sustainable firewood extraction for the satisfaction of their daily needs.

There is a very limited number of economic studies which assess the role of women within collective action institutions for the management and protection of natural resources. One reason lies in the paucity of good quality data that allows for a rigorous analysis of collective action institutions. Agarwal (2009a) is one of the few studies that analyse how the gender composition of community based groups affects forest conservation and management rules. The results reveal that groups with a higher presence of women in the ECs exhibit improvements in forest conditions. However, this existing research focused on relatively narrow geographical areas of Nepal and India using data related to small case studies.

Therefore, the main contributions we want to make with the present analysis are the following. The first novel contribution is the use of the census of all FUGs created in Nepal which is maintained by the Department of Forest of Nepal. This allows concentrating on a wider area of Nepal. In addition, we are able to combine national representative household

surveys data with the census data. This gives unique information for the analysis. Finally, we try to account for potential non-random female participation in the ECs, which most of the existing literature ignored. To the author's knowledge there are no studies that rigorously investigate and address this relevant question. This analysis is extremely important mainly in countries where strong gender division roles exist and where the natural resources are essential to the daily lives of people.

The chapter is structured as follows. Section 2.2 presents a literature review and the analytical framework. Section 2.3 provides a background both on the Nepalese context and on the country's forestry policy. Section 2.4 describes the data, the sample used for the analysis and provides some descriptive statistics of the relevant variables. Section 2.5 presents the empirical strategy and Section 2.6 reports the results and provides some robustness checks. Section 2.7 discusses the results and Section 2.8 concludes.

2.2 Literature review and analytical framework

Forests cover about 4 billion hectares, nearly 31 percent of the earth's land surface. The rate of deforestation has slowed down in recent years. Between 2000 and 2010 the estimated net change in forest area was about -5.2 million hectares per year while between 1990 and 2000 it was -8.3 million hectares. This reduction in forest depletion is attributed to large-scale planting of trees and forest protection programmes (FAO, 2010a). However, forest degradation is still very high in many countries. Indeed, the management and protection of common property resources and of forests in particular has been and remains a global challenge. Over the past decades the widespread concerns on deforestation and forest degradation, specifically of the Himalayan forest, have raised questions on the best ways to limit and counteract this trend and to understand its causes (Baland et al., 2010b, 2013).

Few studies analyse the determinants of firewood collection which is assumed to be one

of the causes of deforestation and forest degradation (Baland et al., 2013, 2010b; Edmonds, 2002; Foster and Rosenzweig, 2003). Poverty has been advanced as one of the hypothesis for environmental degradation. However, some of these studies do not find evidence that poverty is a determinant of deforestation. Poorer households collect less than richer ones, but at the top income level firewood collection starts to decrease. In addition, despite consumption growth appearing to accelerate deforestation, an increase in education, non-agricultural occupations and access to other sources of fuelwood may reduce this pressure on forests, highlighting the importance of distinguishing between sources of growth when looking at the effects of poverty on environmental degradation (Baland et al., 2013).

Understanding the causes of deforestation becomes particularly relevant for determining the ways forests can be protected. The protection of forests and, in general, of common property resources from an overexploitation and hence from depletion as population grows is crucial for defining any developing policy (Wade, 1987). The question is then to understand how best these resources can be protected and managed (Baland and Platteau, 1996).

Common property resources are essential to the livelihoods of a large part of the population mostly in developing countries. Indeed the depletion of these resources, besides posing concerns for the sustainability of the entire world population, becomes particularly worrying for those populations which rely on these resources for their daily lives (i.e., the rural poor in developing countries). Water, grazing land, agricultural land, forests, fisheries are all common property resources. The rights to exploit these resources are held in common with many individuals and these rights can take various forms from an unlimited use to an almost total ban in the access to the resources (Wade, 1987). Essentially common property resources represent a subset of public goods. They are non-excludable but rival in consumption. Unlike public goods, common property resources face problems of congestion, depletion and degradation (Runge, 1986), because their joint

use implies subtractability.

Past literature concentrated on highlighting the failure of common property arrangements which generate a mismanagement of these resources and ultimately cause even more rapid degradation. The basic theoretical argument is that individual incentives inevitably lead to the mismanagament of common property resources. This is indeed well described in three of the most popular theories of collective action summarised by Wade (1987). Specifically, in the *Prisoner's Dilemma* model, rational individuals do not have the incentive to cooperate. The *Tragedy of the Commons* theory (Hardin, 1968), which extends the argument to common property resources, predicts that the private benefit of an overexploitation of a common resource exceeds the private costs of protecting the resource from excessive use because this can be shifted to the whole group. A tragedy of the commons emerges because of the existence of common property rights over a scarce resource. In the *Logic of Collective Action* (Olson, 1965), Mancur Olson argues that a rational individual, unless forced by coercitive mechanisms, will always have the incentive to ignore the social costs of an overexploitation of the resource and act for his own interests. He also adds that only small groups will have the incentive to voluntary cooperate and successfully protect the collective good while large populations will never have this incentive (Olson, 1965).

As a result of these theories, the tendency therefore was to give a relatively small role to local collective action institutions for environmental protection and economic development. However, since the mid-1980s the discussions on which type of institutional arrangement is best for common property resource management changed and a vast literature on common property arrangements emerged (Agrawal, 2001). This more recent literature claimed for the success of collective action[2] as an effective alternative to private resource management or state regulation of a common resource (Baland and Platteau, 1996; Wade, 1987). The

[2]Collective action is 'action by more than one person directed towards the achievement of a common goal or the satisfaction of a common interest' (Wade, 1987, p.97).

claim was based on the recognition that the above theories hold under the assumption that individuals cannot communicate, which is implausible in many situations (Wade, 1987). As a result voluntary collective action institutions can emerge and be successful in protecting the common interest if effective rules and related sanctions are established within the group.

Since then the belief that local communities through the formation of collective action institutions could successfully manage common property resources and hence contribute to environmental protection and local development became relevant (Baland and Platteau, 1996; Bardhan, 1993). 'Participatory development' and 'community driven development' became common themes across countries with natural resources to protect (Hobley and Shakya, 2012).

However, Baland et al. (2007), while proclaiming the potential of small rural communities in achieving the goals of environmental protection and economic development, emphasise that group heterogeneity may lead to a failure of these institutions. Often a failure of collective action institutions in protecting common property resources (e.g., forests) results from inequalities within the groups which prevent them from successfully cooperating. The authors stress the relevance of various dimensions of inequality. In particular, income and asset inequality matters as well as ethnic and social heterogeneity which may influence the well functioning of collective action institutions. Group participation may be lower in localities that are more unequal in terms of income and ethnicity (Alesina and La Ferrara, 2000). Most importantly for the current analysis, gender inequality within groups may affect the level of cooperation. Women are largely excluded from any decision making within community groups. In addition, gender norms and divisions of roles within the household have tended to exclude women at many levels within society. This underrepresentation together with pre-existing gender inequalities within the household and the society as a whole, poses serious concerns for women who have the primary responsibility

for the collection of forest products within the household (Agarwal, 2007). This suggests that the nature of dependence on forest is different between women and men. Women have a higher interest then men in ensuring the availability of firewood and other forest products essential for their daily life. This is also related to the burden associated with a deterioration in forest conditions (Acharya and Gentle, 2006). Environmental degradation and natural resource scarcity affects women and children's time directly, given they have to walk longer distances for the collection of firewood (Cooke, 1998). Similarly, women and children's health may be adversely affected by fuelwood scarcity. Indeed, the use of firewood in an enclosed environment (i.e., a house) is also potentially unhealthy.

Besides having different *interests* than men, women in general may have different *preferences*. Income generated within the FUG could be more equally distributed if more women had power at the decision-making level. Women would also be more prone to favour investments related to their needs and to those of their children (Agarwal, 2010b). This strand of research on women in collective action institutions links to another literature which analyses female representation in public decision-making. Women and men have different policy priorities. This literature demonstrates that women in key political positions tend to favour public goods that emphasise investing more on child-related expenses (Clots-Figueras, 2012). Female political representation also tends to attenuate the gender bias in voter attitudes towards women (Beaman et al., 2009). Chattopadhyay and Duflo (2004) report how the gender of those in key political position affects the type of public good provided and show that women tend to favour public goods which are more linked to their concerns. Therefore, any surplus income generated within a FUG is likely to be spent disproportionately on goods and outcomes such as health and children's education.

Much of the research which looks at the effects of collective action institutions and of the role of women within local forest groups, concentrate on India and Nepal. The reason for this lies in the recent reforms enacted by the governments to address issues of

environmental degradation.[3] Edmonds (2002) is one of the few studies on Nepal which attempts to rigourously evaluate the impact of collective action institutions established for the management of forests on environmental degradation. The results seem to suggest that FUGs in Nepal have been successful in reducing firewood extraction and hence forest degradation. This study focuses on the short term effects of these institutions as it evaluates the effect of the 1993 reform in 1996. Two other recent studies do not find any significant correlation between firewood collection and the presence of FUGs in communities in Nepal (Baland et al., 2010b, 2013).[4] The remaining empirical analysis mostly concentrates on relatively small case studies which acknowledge the success of FUGs activities in Nepal in halting deforestation (Kumar, 2002; Hobley and Shakya, 2012). However, these latter studies ignore the potential endogeneity of community group formation on relevant outcomes. Baland et al. (2010a) demonstrate that ignoring this potential endogeneity bias may lead to an under-estimation of the benefits of community forest management.

However, the success of community forestry in Nepal has been challenged in a more recent literature which stresses how most of the benefits accrued to local elites (Thoms, 2008; Malla et al., 2003). Participation in FUGs is found to be higher for more economically advantaged groups (Agrawal and Gupta, 2005). Adhikari et al. (2004) show that richer households benefit more in terms of forest access and distribution of benefits than poorer ones, highlighting the importance of making these groups more inclusive. The exclusion of some sub-groups within these local community institutions may indeed cause failure in terms of both equity and efficiency of these groups (Agarwal, 2001). The success or failure of collective action institutions depends also on their design and characteristics (Baland and Platteau, 1996; Edmonds, 2003; Olson, 1965; Ostrom, 1990; Wade, 1987). For example, many local community groups in Nepal are created with the assistance

[3] We will discuss Nepal forestry policy in the next section.

[4] However the authors claim they are not able to assess any causal effect given the non randomness of group formation.

of donors. Differences between donors in terms of funding or objectives may reflect the attributes of the groups which as a result will have different characteristics (e.g., number of members, area covered). This heterogeneity eventually affects the success or failure of some of these groups and, more generally, of programmes which devolve to local communities the management of natural resources (Edmonds, 2003).

Some recent research focused on explaining why gender matters in environmental collective action and what type of differences women can make to the management of forests (Mai et al., 2011; Agarwal, 2000, 2010b). A higher presence of women may indeed generate different outcomes in terms of forest conditions. Agarwal (2009a) analyse how the gender composition of community based groups affect forest conservation and management rules. The results on Nepal and India reveal that groups with a higher presence of women in the ECs of FUGs show improvements in forest conditions. Sun et al. (2011) look at correlations between the gender composition of a sample of FUGs in Kenya, Uganda, Bolivia and Mexico and property rights and forestry management. They find that groups with a balanced presence of women and men tend to participate more in decision-making processes within the group, but do not find any effect on firewood collection. On the contrary groups where women are the majority (i.e., more than two thirds) tend to collect more firewood, though participating less in decision-making. This result may be attributable to the particular conditions under which groups with a large majority of women are formed as will be discussed later.

Agarwal (2009a) illustrates that one mechanism through which a higher female presence in the groups improves forest conditions is through a better quality of forest protection. Women who take up some responsibilities within the group have the incentive to follow the rules (Bardhan and Dayton-Johnson, 2007) and to bring their concerns into the group's discussions. Female involvement in the decision-making process would also help to spread awareness of the rules among village women, generating an informational flow. The

gender composition of the ECs of FUGs may affect differently the type of rules on forest access, resource extraction and the distribution of benefits defined within the groups given different female priorities in terms of resource extraction. Agarwal (2009b) finds in Nepal and India that groups with more women tend to favour stricter rules which in turn favour forest regeneration. The author stresses also that rules which are too strict are difficult to enforce and may favour violations and conflicts. Hence a well balanced strictness of rules may facilitate forest protection giving incentive to FUG members to cooperate. The results show that more women in ECs appear to favour stricter rules which would allow forests to regenerate.

This reviewed literature suggests that the need for greater gender equality is still urgent and is reflected in the fact that one of the most recent World Development Report's focus was on gender (WB, 2011). Another recent World Bank report on women in agriculture also highlights the importance of women in forestry and in general in natural resource management devoting two chapters to these issues (WB/FAO/IFAD, 2009).

2.3 Nepal context and forest policy background

2.3.1 General context

Nepal is an apposite country to analyse as the forest is one of the most important natural resource in the country. In addition, the large majority of the population in the rural areas depends on forest resources for subsistence (CBS, 2004, 2011). Recently, commercial interests over the forest sector started to emerge. These new patterns are increasing the awareness that this shift could potentially lift the population relying on forests out of subsistence (Pokharel et al., 2008). Forestry now represents a productive sector of the economy and is estimated to comprise around 10 percent of Nepal's GDP (Hobley and Shakya, 2012).

Concerns over forest degradation have emerged in Nepal since the 1980s. According to FAO, in 2010 Nepal forest coverage was estimated at about 3.6 million hectares, which represents nearly 25.4 percent of the total land area of Nepal. Despite the decreasing rate of forest degradation in the last number of years, recent estimates suggest that between 1990-2010 Nepal lost a quarter of its forest cover (FAO, 2010b).

Nepal is divided into 75 administrative districts. These are grouped into three diverse ecological belts running from north to south - the Mountains which lie in the north at altitudes above 4,000 meters, the Hills in the middle which comprise fertile valleys, river basins and steep terrain, and the Tarai in the south which includes fertile lands and most of Nepal's dense forest. This variety of topography and elevation renders Nepal a very heterogenous country given its climate. Each ecological belt is further divided into five development regions - eastern, central, western, mid-western and far-western regions. Nepal is also very heterogeneous in terms of income, caste and ethnicity (Ojha et al., 2008). Social norms prevail and there is a fairly sharp gender division of labour (Hobley and Shakya, 2012).

As discussed already the female role in forests is essential (Mai et al., 2011). Despite the fact that women are still largely under-represented at all institutional levels in Nepal, forestry is now the sector where the presence of women in key positions is highest (Pokharel et al., 2008). The attention toward female social inclusion and empowerment in Nepal increased substantially in recent years at different levels within society and in particular in the forestry sector as testified by the recent Gender Equality and Social Inclusion strategy (Pradhan, 2010) and by the Forest Sector Gender and Social Inclusion strategy (MFSC, 2012).

Nepal in the past two decades witnessed significant political, social and economic changes. In 1996 a Maoist insurgency initiated a conflict in the country between the Communist Party of Nepal (the Maoist) and government forces. This was triggered by

the most marginalised groups (ethnic and low-caste groups) living in rural areas. It started in the western regions but soon extended throughout the country. In 2001 the conflict intensity escalated and ended in 2006 with the signing of a peace agreement. Despite this relatively intense decade of conflict, the Nepalese economy experienced a significant growth over this period. Between 1996 and 2004 poverty rates reduced from 42 to 31 percent, and between 2004 and 2011 the poverty rate further reduced to 25 percent (Hobley and Shakya, 2012).

2.3.2 Forestry background

In this section we first provide a historical background to forestry in Nepal. We then specifically focus on Community Forestry and provide a summary of the main phases and changes it went through. Finally we give an overview of FUGs definition, formation and characteristics.

History of forestry policies and legislation

The Nepalese forestry sector legislation has gone through many changes since the early 20th century. Three main phases can be distinguished (Hobley and Shakya, 2012; Ojha et al., 2008; Chhetri, 2006; Acharya, 2002).

Privatisation (pre-1950s): Nepal before unification (in 1769) was divided into several small kingdoms, characterised by low population and an abundance of resources. Since then, the monarchy that ruled the country along with other state nobilities, encouraged the conversion of forests into agricultural land and the clearing of forests to extract timber for trade. This pattern continued also during the regime of the Rana family, one of the state nobilities, who ruled the country between 1846-1951. Forests during this period were a source of income for the elites (Chhetri, 2006).

Nationalisation (1957-mid-1970s): Severe deforestation in these years led the govern-

ment to nationalise forests in 1957 to undermine local tenure rights, and culminated in the Private Forest Nationalisation Act of 1957. Despite the purpose of the Act was to protect forests, its open access arrangements made the situation worse as a lot of forestland had been cleared during these years, mostly in the Tarai. The pressure on forests in Tarai was even higher due to large migration inflows toward this area after the 1960s (Hobley and Shakya, 2012; Ojha et al., 2008).[5]

Community orientation (late 1970s): The failure of centralised arrangements for the protection of forests together with the rising international concerns over Himalayan degradation, influenced the emergence of participatory development to oversee forest management. The recognition of a role for local communities started with the National Forestry Plan in 1976 and with the 25-year Master Plan for the Forestry Sector (MPFS) approved by the government in 1989 (Ojha et al., 2008; Gautam et al., 2004). However, the new forestry legislation which legally established the transfer of forests to local communities was promulgated in 1993 with the Forest Act (HMGN, 1993a). The Act categorised part of the national forests as Community Forests (CF).[6] These are forests collectively managed by local communities who have formed a Community Forest User Group subsequent to approval of a local district forest office (Gautam et al., 2004). Once the CF is handed over to the FUG, this can independently manage, conserve and use the forest according to an operational plan while the land ownership remains with the state (Ojha et al., 2007). The Forest Regulation of 1995 (HMGN, 1993b) represented the first operational tool for the implementation of the Forest Act.

[5]Until the 1950s malaria was prevalent in the Tarai belt which was finally eradicated in the 1960s and induced large migration inflows into the area (Gautam et al., 2004).

[6]Community Forest is only one of six different institutional arrangements of the wider programme in Nepal on Community Based Forest Management (CBFM). See Acharya (2002), Gautam et al. (2004), Kanel (2004) and Ojha et al. (2008) for a review of all modalities.

Evolution of Community Forestry and main policy changes

Most of the FUGs started to form in the middle Hills and very few formed initially in the Tarai despite half of the population residing there and with the region including a big proportion of forest land. Still today Tarai is the region with the lowest number of FUGs. One explanation for this lies in the fact that forests in Tarai were more valuable and the government was reluctant to hand over its management to local communities, making also any donor interventions difficult. This area is characterised by higher ethnic heterogeneity than other regions, is more accessible and had significant migration inflows in the 1960s. Multiple interests emerged in this area which hindered the formation of FUGs and pushed the government to implement a different forest policy for Tarai[7] (Hobley and Shakya, 2012; Ojha et al., 2008). Given the very different context and policy framework of the Tarai belt and given that the bulk of FUGs was formed in the Hills and the Mountains, we exclude Tarai from our current analysis.

During the 1990s, CF expanded rapidly throughout the country. The objective of CF in Nepal was the protection and management of forests with the clear aim of halting forest degradation in Nepal. A strong focus on learning and exchange between groups was put in place (Hobley and Shakya, 2012). The process of handing forests over to local communities required the assistance and support of both officers from the Department of Forests (DoF) (i.e., District Forest Office (DFO) officers) and international donors. Initially the DFO staff was essential for facilitating and supporting FUG formation (Edmonds, 2002). FUGs formation have also been largely supported by donor-funded projects (Edmonds, 2003).

During the 2000s the expansion of FUGs slowed down. This occurred at the same time as the escalating violence due to the conflict in these years and to a change in attitudes and objectives of CF. While success up to this period in terms of forest conservation

[7] Terai Forest Policy in 2000 (Ojha et al., 2008).

was acknowledged, the effects on marginalised and more vulnerable groups were unclear. Problems of elite capture started to emerge. Issues of poverty, equity, inclusiveness and in general of the rebalancing of power were recognised not to have been adequately addressed and hence incorporated within CF objectives. The operational guidelines for FUG formation were revised in 2001 incorporating only part of these new objectives (MFSC, 2001). Not only did the scope of FUGs widen and evolve over these years but the role of government (through the DFOs) and the role of donors also changed. Other actors within the civil society (NGOs, FECOFUN[8]) acquired a more relevant role in facilitating communities to form groups. The decrease in the role of government officials in these years was also coincident with the escalation of the conflict which impeded the free movement of officials around the country (Pokharel et al., 2008). The emergence of a civil society voice also testified to the need for a more democratic push and less intervention of the state through its forest officials. In addition, as a result of the conflict, many donors withdrew their financial support. Of the six major donors that supported FUGs in most of Nepal's districts only three remained in the country. Despite this, most FUGs continued to function and to rely on their self-generated income for their financial sustainability (Pokharel et al., 2008).

After the end of the conflict in 2006 an increasing emphasis was placed on extreme poverty and inclusiveness of the most marginalised groups. CF evolved from just being a government-supported programme into an extensive system which continues in most of Nepal indipendently of external support. FUGs are now conceived as vehicles for local development, representing in some places the most democratic institutions in the country and acting as a source of cash income, physical infrastructures and other rural development activities. CF have now a strong influence on local democracy and inclusive self-governance

[8]FECOFUN is the Federation of Community Forest Users in Nepal which represents FUGs rights and interests in Nepal and was established in 1996.

(Pokharel et al., 2008).

In 2009, the operational guidelines for FUG formation have been revised for the second time (MFSC, 2009). These new guidelines put a greater emphasis on poor and excluded groups (Dalit, women, indigenous people and ethnic minority groups), including mandatory provisions for representation of all categories of users and equitable distribution of benefits among them. It is also specified that FUGs have to spend 25 percent of their income on forest development activities, an additional 35 percent should be used for programs that target the poor and excluded groups and the remaining amount should be spent on other community development activities (e.g., drinking water supply, schooling infrastructures) (MFSC, 2009; Pokharel et al., 2008). Therefore, surplus income generated within the groups could be spent on initiatives other than protecting the forests.

A specific new provision was introduced for female representation that in particular indicates that there should be at least 50 percent of women representatives in the Executive Committee (EC), the main decison making body of FUGs. Previous guidelines of 2001 only specified that 'The Committee should represent men, women and interest groups from each *tole*[9] proportionately' (MFSC, 2001, p.14). We exploit the amendment made to the 2009 revised guidelines in terms of female representation in the ECs as identification strategy in the subsequent empirical work.

Definition, features and process of formation of FUGs

The 1993 Forest Act established that all government forest land should be devolved to local communities for forest management and protection. As explained above, FUGs are legal and autonomous bodies which have full power and authority over forests whose ownership remains in the hands of the state. Each FUG has the right and responsibility to manage, protect and use forests. All benefits from CF go to the FUG. All management decisions are

[9] A *tole* has a size of a hamlet.

taken by FUGs and each member should have in principle equal rights over the resources. Each household is recognised as a unit for membership and anyone who is not member of the FUG is excluded from access to the CF. Another important feature of FUGs is that they have no political-administrative boundaries but traditional use rights. This implies that one FUG may cover more than one community and vice versa.

Each FUG has two main bodies in its organisational structure: a General Assembly with members drawn from the whole community and an Executive Committee (EC). The EC is the key decision making body which, in conjunction with the General Assembly (and in varying degrees with the forest department) defines the rules for forest use and benefit sharing, the penalties for rule violation, methods of protection and so forth. Forest use rules may restrict access to the forest and these restrictions can range from almost a total ban on extraction of forest products to varying degrees of permitted extraction on firewood, fodder and other forest products (Agarwal, 2010a,b). The benefits derived from FUGs activities should be equally distributed among members, though in practice, as already acknowledged, this has not always happened (Acharya, 2002).

The composition of the committee is thus a critical issue in terms of decisions about the use of a community forest. In principle the Executive Committee should have representation from all members, and thus its decisions will reflect the needs and desires of all members (Yadav et al., 2008). In practice many groups have been excluded from any decision making process and most of the benefits have been reaped by local elites. The new provisions included in the revised guidelines in 2009 aimed at mitigating these patterns.

The process of FUG formation is a long process which goes through different steps that eventually end up with the transfer of the forest area to the FUG and to the approval of an Operational Plan by the DFO (MFSC, 2009). The process starts with the identification of users and forest area.[10] After discussions among potential users, a group is formed. As

[10]Generally users are households that are 'traditional users of the forest, close to the forest, interested to

discussed above the process is often facilitated by DFOs, donor-funded projects or NGOs. The members compose a framework constitution which has to be approved by the General Assembly. The Executive Committee is formed. FUG members send an application for registration of the FUG to the DFO. Once the FUG is registered the members write the Operational Plan (OP) of the FUG and send an application for its approval to the DFO.[11] The main features that the OP has to include are the details of the forest (e.g., boundary, area, type, condition etc.), management objectives, demand and supply of forest products, rules for forest products extraction and monitoring and provisions for fines and punishment in case of rule violations (MFSC, 2009). Finally, the DFO issues a certificate of approval of the Operational Plan and the Community Forest is handed over to the FUG.

2.4 Data, sample and descriptive statistics

2.4.1 Data

This study uses two main sources of data. As a first source we use two national representative random cross-section surveys collected by the Central Bureau of Statistics in Nepal (CBS) in collaboration with the World Bank. This data is linked at the village level to a second source of data which is a census of all CFUGs in Nepal. This additional data contains FUG related characteristics necessary for our empirical analysis.[12] Our sample will include only villages which have formed at least one FUG at some point in time.

Specifically we use the 2003/2004 and the 2010/2011 Nepal Living Standards Surveys (2004 NLSS Survey and 2011 NLSS Survey hereafter). They are both nationally represent-

get involved in the user group, depend on the forest for forest products, can contribute to the protection and management of forest, distant users of the forest which have no other alternatives for forest products but can contribute to forest management'(MFSC, 2009, p.3).

[11] Informal discussions with practitioners informed us that in practice the OP and the FUG constitution are usually submitted to the DFO together.

[12] The NLSS surveys also contain FUG related information in the rural community questionnaires. However, not all the data we need for our analysis is available. For example there is no information on the gender composition of the EC. Therefore we are not using this information for our analysis.

ative surveys and their construction follows the standard methodology used by the World Bank in all its Living Standard Measurement Surveys. The first survey was conducted between April 2003 and April 2004 (CBS, 2004). The second was conducted between February 2010 and February 2011 (CBS, 2011). These surveys are respectively the second and third round of the 1995/1996 NLSS Survey conducted to update living standards and social indicators of Nepalese population.[13] Both surveys provide information on a wide range of village, households and individual characteristics. We use for this analysis only village and household level information. In the 2004 NLSS cross-section survey the sample includes 4,008 households and 334 Primary Sampling Units (PSUs).[14] The conflict that prevailed in various parts of the country over this year impeded fieldwork in some of the PSUs. Therefore, eight PSUs in the rural areas could not be enumerated.[15] As a result the actual sample of the 2004 NLSS surveys includes 3,912 households in 326 PSUs. In the 2011 NLSS survey, 5,988 households from 499 primary sampling units (PSUs) have been enumerated for the cross section sample. Despite the sample frame considered all districts of Nepal, six districts out of 75 were not selected in the 2004 and 2011 NLSS cross-section surveys due to their low population or for conflict related reasons (CBS, 1996, 2004, 2011).[16] For some robustness checks and descriptive statistics we also make use of the 1995/1996 NLSS survey.

As mentioned above, our second source of data is the FUG Database, a census of all Community Forest User Groups created in Nepal through July 2011 (MFSC, 2011). The

[13]In order to look at changes over time in these indicators, some households have been tracked over these three points in time. Therefore panel survey data is also available. However the 2010/2011 NLSS survey panel data was not made available to us yet.

[14]Primary Sampling Units are either individual wards or sub-wards or groups of contiguous wards in the same Village Development Committee (i.e. a village). A ward is the smallest administrative unit according to the Population Census.

[15]The missing PSUs are one from the Central, one from the Mid-Western and 6 from the Far-Western regions. The Far-Western region was indeed one of the areas mostly affected by the conflict.

[16]Specifically, the Dolpa, Humla, Manang, Mustang districts were not included in the 2011 NLSS survey and the Accham, Dolpa, Mustang and Rasuwa were not selected in the 2004 NLSS survey. Mustang was an independent kingdom within Nepal until 2008.

FUG Database is maintained by the Department of Forest (DoF) of Nepal. It contains data on every forest user group formed in Nepal up to July 2011. This is the date by which the data has been made available to us. This census contains information on the date of formation,[17] the district and village (i.e., Village Development Committee, VDC) covered, the number of members in the Executive Committee, the number of females in the EC, the area of forest handed over to the FUG and the number of households who participate in the group. All the FUGs related characteristics refer to the time of formation. Therefore, there is no data on changes that may have occurred in the FUGs characteristics over time. We believe however that this does not substantially limit our analysis. Indeed once formed, the ECs of FUGs normally do not change for many years (Agarwal, 2009a). In addition, even though the composition of the ECs could have changed over time this change should occur in a systematic way across all groups in order to affect materially our results.

In order to use both sources of data we need to merge them. The FUG Database is at the FUG level. Unfortunately, we do not have information on whether a specific household surveyed in the NLSS is a member of a particular FUG or another. Therefore, we are able to merge the two datasets only at the village level. The NLSS Surveys are at the ward level (*community*/PSU level) which, as acknowledged earlier, is a smaller geographical unit than the village (i.e., the VDC). This match may generate a potential bias. However, villages in Nepal are small and quite homogeneous units. In addition, our sample includes only villages which formed at least on FUG and in both NLSS surveys usually one ward per village was sampled. Therefore, any potential bias emerging from this imprecise match should be very small.

[17] This date is referred formally to the Operational Plan approval date.

2.4.2 CFUGs in Nepal: some patterns

According to the FUG database, by July 2011, 17,685 FUGs were formed all over Nepal, covering a total of 1.6 millions hectares of forest land and including 2.2 millions households (MFSC, 2011). By the end of the 2004 NLSS Survey in April 2004 and also by July 2011 all districts of Nepal except one[18] had formed at least one FUG. This reflects the importance of FUGs formation in Nepal. A rough calculation on the basis of 2010 estimates on the Nepalese forest cover (FAO, 2010b) suggests that the 44 percent of forest area in Nepal is now covered by FUGs.

Table 2.1 reports some characteristics of FUGs according to the census. Consistent with the fact that the area where most FUGs formed over these years is the Hill belt, by 2011, 74 percent of FUGs were formed in this area. Another 14 percent were formed in the Mountains and 12 percent in Tarai. On average, the percentage of women in the Executive Committee of FUGs is 33 percent. The number of observations in Table 2.1 reveal that some information on these variables is missing. The percentage of missing observations on the proportion of women is nearly nine percent. We have looked at the average characteristics of the FUGs for these observations to see if they are largely comparable to those in Table 2.1. Summary statistics in Table 2.A.1 of the Appendix show that some differences emerge.[19] However, as the percentage of missing observations is quite limited, it is unlikely that the results will be substantially affected by this. In addition, as we will explain in subsequent sections, in part of our empirical strategy we

[18]The missing district is Mustang. As already remarked this was an independent Kingdom within Nepal until 2008.

[19]Table 2.A.1 of the Appendix shows that there is a higher proportion of FUGs for which there is missing information on the percentage of women in the Far Western region. This region is one of the least accessible and this may also explain why some information is not available. Also these groups are characterised, on average, by a lower area of land. We have checked whether this missing information is mostly related to FUGs created early on or to more recent ones and we find it is related to early FUGs. As will be shown below, FUGs created earliest had a lower percentage of women in the ECs of FUGs. We may therefore advance the hypothesis that the FUGs for which the information on the number of women is not available are those with a lower proportion of them. Hence, if we think that the missing observations reflect a lower percentage of women we expect the average in the percentage of women to be higher.

are not using the variable related to the percentage of women. Hence, the related estimate should not contain any bias related to this missing information.

We plot some FUG characteristics against time of formation in order to determine whether FUG created earlier on are different in terms of their characteristics to those formed in more recent years.[20] First, we plot the years of formation of FUGs against the average percentage of women in the ECs and we notice an increasing trend with a peak from 2010 (Figure 2.1). This pattern is consistent with the fact that in 2009 the operational guidelines for FUG formation were changed (see Section 2.3 above) and incorporated a new provision for female representation in the ECs of FUGs. The figure shows that FUGs created after 2009 exhibit a higher percentage of women in their ECs. We test whether the increase in female participation in FUGs formed after 2009 is significant. We regress the percentage of women in the ECs of FUGs on a trend and on a dummy which indicates whether a FUG was created after 2009 (i.e., in 2010 or 2011). The results in Table 2.A.2 in the Appendix show that there is a positive and increasing trend in female participation over time. The results also reveal that FUGs created after 2009 have a significantly higher percentage of women above the trend by 3.5 percentage points. We also regress the percentage of women in ECs of FUGs on a set of dummies on the year of FUGs formation. Table 2.A.3 in the Appendix reports that across all model specifications in which we use the 2009, 2008, 2007 and 2006 year of formation respectively as reference category, groups formed in 2010 and 2011 have a significantly higher percentage of women relative to those formed in earlier years. In order to further assess whether FUGs formed after 2009 have a higher percentage of women relative to those formed before we show in Table 2.2 a breakdown of the percentage of women by different dates of formation of FUGs. The first column shows that most of the groups have a proportion of women in the ECs below the

[20] To note that we exclude from the following descriptive statistics all FUGs created in the Tarai as it is not part of this analysis as outlined above.

50 percent. There is a 7.8 percent of groups with a percentage of women in the ECs above 50 percent and a 5.6 percent with all women in the ECs. It is visible from the table that as we move towards the latest years of formation the proportion of groups with a higher percentage of women is larger. For example, the 45 percent of groups formed in 2011 have women between the 33 and the 50 percent threshold in the ECs relative to a 41 percent of those formed between 2007 and 2009. Similarly, another 21 percent of groups formed in 2010 and 2011 has a proportion of women in ECs above the 50 percent compared to seven percent for those formed between 2007 and 2009. These patterns will be used in subsequent sections as a basis for our identification strategy.

We looked also at the progression of FUGs formation over time in Nepal. Figure 2.2 reveals that there is an immediate increase in the number of FUGs formed right after the reform in 1993. The bulk of FUGs have been formed between 1994 and 2000. The rate of FUGs formation then slowed down possibly, as mentioned in Section 2.3, due to the intensification of the conflict after 2000 and up to its end in 2006. After this year, as the figure shows, the number of new FUGs created starts to increase again. The decline corresponding to new FUGs formed in 2011 is attributable to the fact that the information we have only refers to half of that year. We expect, therefore, that the number of FUGs for 2011 is somewhat higher. In addition, given that the trend in the percentage of women in ECs is increasing, we expect that the FUGs formed in the second half of 2011 have a percentage of women in the ECs as high as the one of the FUGs formed in the first half of 2011. Figures 2.3 and 2.4 exhibit patterns very similar to those noted above. Indeed, there is a big increase in both the area of forest transferred over and in the number of household members of FUGs in the years immediately following the 1993 reform. The 1994-2000 years are those during which larger areas of forest have been handed over to FUGs and in which many households became members of the groups. Table 2.A.4 in the Appendix summarises these patterns. At the regional level FUGs started to form

in the eastern, central and western region and progressively expanded toward the mid-western one. However, despite the eastern, central and western regions having a consistent proportion of FUGs formed also during the years in which the conflict was most intense (2001-2006), the mid-western region has a higher proportion of FUGs formed after the end of the conflict and in the more recent years. In the far-western region a smaller proportion of FUGs have been formed as compared to other regions with this proportion considerably declining starting from 2001. This is again consistent with the fact that the conflict was most intense in the Western regions.

We note also that there is a negative relationship between the area of forest handed over and the percentage of women in the ECs as groups start to have larger numbers of women (Figure 2.5). Interestingly groups where the ECs are composed by the one hundred percent of women, manage much smaller areas of forests. This pattern is consistent with the literature on female-dominated FUGs in Nepal (Ray-Paudyal and Buchy, 2004; Agarwal, 2010b). Indeed, in many districts women-only FUGs have been established as a result of a pressure to include women in the decision-making process of these institutions. However, these groups were usually allocated more degraded forests and smaller areas which made them even more marginalised. A similar relationship is visible between the number of households and the percentage of women. So groups with a higher proportion of women in the ECs on average seem to be characterised by a smaller area transferred and a lower number of households in the group. We have checked further this relationship and noticed that the average area of forest handed over to women-only groups is much lower for groups formed before or in 2009 than for those formed after 2009. This may suggest for a shift in attitudes towards the role of women after 2009.

To conclude, these patterns show a different evolution of FUGs over time both in terms of their characteristics and at the regional level. Edmonds (2002) looks at the effects of FUGs on firewood collection accounting for the fact that FUGs formation did

not occur randomly around Nepal. The process of forest transfer and group formation occurred gradually over time. Areas that formed groups earlier on could have different characteristics than those that formed groups in later years. Edmonds (2002) finds that areas more accessible, located close to markets, to forestry offices, with a higher presence of user groups other than forestry ones, with presence of agricultural technical assistance, were more likely to form groups earlier on. Our sample includes only villages that have formed FUGs at some point in time. In all our specifications we control for the year of formation of FUGs and for district fixed effects to account for differences between villages that formed groups earlier or later.

2.4.3 Sample

In order to merge the FUG census to the NLSS surveys to obtain the sample used for our analysis, we select from the FUG Census only villages that have been sampled in the NLSS surveys. The FUG Database covers all villages in which FUGs have been formed, while the NLSS data are nationally representative surveys in which only a sample of villages and households have been randomly selected. Therefore, from the 17,685 FUGs in the census we end up with a sample of villages which include 2,047 FUGs. To note that the NLSS surveys despite being representative of villages and households have not been designed to be representative of FUGs. We have checked that the characteristics and patterns are similar between all the FUGs in the census and this selected sample of villages. Table 2.A.5 in the Appendix shows that most of the characteristics are similar to those shown in Table 2.1.[21] We have also plotted some FUGs characteristics against the FUG time of formation. Figure 2.A.1 in the Appendix shows a pattern mostly similar to Figure 2.1 above. There is, however, a bigger variation where peaks and troughs are more accentuated due to the

[21] To note that the sample of villages we are considering does not include the Tarai belt. Therefore some regional differences between this table and table 2.1 may be due to this.

smaller sample size. As a result the pattern is less smooth. Table 2.A.6 in the Appendix shows, similarly to Table 2.2, that there is a higher proportion of groups formed in 2010 and 2011 which have a percentage of women between the 33 and 50 percent and above the 50 percent relative to those formed in earlier years. Figures 2.A.2, 2.A.3 and 2.A.4 in the Appendix suggest a very similar pattern to those shown in the same respective plots based on the whole census (figures 2.2, 2.3 and 2.4).

We construct FUGs related variables at the village level as there can be more than one FUG in a village. Specifically, we create a variable for the number of FUGs in a village and we calculate the village average of other FUG characteristics (i.e., percentage of women in the ECs, area of forest handed over and number of households in the FUGs) over all FUGs formed in each village up to the end of each survey period (i.e., April 2004 and February 2011).

We can then merge at the village level, the FUG Database to the NLSS surveys from which we exclude urban and Tarai villages. Out of the 127 and the 183 villages surveyed in the 2004 and 2011 NLSS rural surveys, five and nine villages respectively did not form any FUG according to the FUG census. As a result the 95 percent of the surveyed villages in the Hills and Mountains formed at least one FUG by July 2011. As our sample has to include only villages which have formed at least a FUG, we exclude from our sample these 14 villages that did not form any FUG by July 2011. We nonetheless check whether the characteristics of villages and households in these villages are different relative to those that we select for our sample. Table 2.A.7 in the Appendix reports these descriptive statistics. The results are consistent with the non existence of FUGs in these villages.[22]

[22]Indeed, a lower percentage of households report having used firewood in the past 12 months and use firewood as a cooking fuel. Consistently a higher percentage of households use gas, oil or kerosene as a primary source of cooking fuel, which are superior type of fuels. Also there is a lower percentage of these households which collect firewood from the community forest and a higher proportion that collect from government forests. There is a higher proportion of these households which use electricity as light source and that have higher per capita nominal expenditures. Also these households appear to own or cultivate a lower number of hectares of land and own a lower number of livestock. These statistics may suggest that these households are possibly richer on average than those we consider and less dependent on forest

We also exclude from our sample two villages (one from the 2004 and one from the 2011 NLSS surveys, corresponding to 24 households in total) which according to the FUG Database did form some FUGs, but only after 2009. These may be quite different villages as the process of FUG formation started in 1993. We did however a robustness check including these two villages and the results are not altered.[23]

The number of households surveyed in the two NLSS surveys in the Hills and Mountains belts are respectively 1,524 and 2,196. After excluding the villages with no FUGs according to the census and with no FUGs formed before 2010, we are left with 1,452 and 2,076 households in the sample respectively for the 2004 and 2011 NLSS surveys. We need to further reduce our sample to those households that use and collect firewood in the past 12 months. These households represent the 97 and 96 percent of households respectively for the 2004 and 2011 surveys and confirms a high dependency on this resource.

There are 16 observations for which the quantity of firewood is not available for the 2011 NLSS survey and these are excluded from the analysis. Finally we do not include in our analysis the four observations in the 2011 NLSS survey which have a value above 1000 for firewood collection. Looking at the distribution of the quantity of firewood collected, these values appear to be outliers. We have estimated our model including these observations and the results are not materially affected (Table 2.A.8 in the Appendix). Our final sample includes 3,252 households (1,361 correspondent to the 2004 NLSS and 1,891 correspondent to the 2011 NLSS in 121 and 172 villages respectively).

2.4.4 Descriptive statistics

We report in Table 2.3 summary statistics on household and community level characteristics for the 2004 and 2011 NLSS survey samples as defined above. The average annual

products and agriculture for their subsistence.

[23] Results not shown and available upon request.

amount of firewood collected by the households decreased by eight percent between 2004 and 2011 which may suggest for a reduction in forest depletion.[24] Firewood is measured in bhari which is defined as roughly a bundle (a headload) of wood whose size/weight depends on the person carrying it.

We note that in both samples most of the households use firewood as main cooking fuel, which implies a high forest dependency. On the contrary, the proportion of households which use gas, oil or kerosene as a primary source of cooking fuel is just the 2.4 and 3.1 percent for the 2004 and 2011 surveys respectively. This implies that the use of fuels of higher quality is quite rare in this sample of rural households. The survey provides information on the place where households collect firewood and in particular whether they collect it in their own land, in community forests or in government forests. We note that the percentage of households that collect firewood in community forests is quite high and in 2011 is higher than the percentage of those that collect it in government forests. We also looked at the same descriptive statistics using the 1996 NLSS survey and we could notice that the majority of the households were collecting firewood in government forests (60 percent) and a minority in community forest (14 percent). This is a reflection of the gradual implementation of the Forestry Act in 1993. Although informative, this variable provides only imperfect information on whether households in our sample are members of FUGs.

The surveys provide some information on forest conditions and in particular survey respondents have to say whether the area under forest decreased in the past five years and whether the time taken to collect firewood increased over the same period.[25] These

[24] We are not able to distinguish between the collection of fallen twigs (which may not imply forest degradation) and the cutting of drywood from the trees (which may generate actual forest depletion). However we use firewood collection as a measure of forest degradation consistently with the existing literature (Baland et al., 2013, 2010b; Edmonds, 2002; Foster and Rosenzweig, 2003). In addition, the advantage of looking at firewood collection as a measure of forest degradation is that it is directly related to women as they are the primary collectors of this resource.

[25] As these are subjective measures, they might not measure precisely forest conditions. For example, current and historical satellite data would be more informative about forest conditions. However, we have

variables seem to indicate that forest conditions have deteriorated between the two surveys as a higher proportion of villages seems to show a decrease in the area of forest and an increase in the time to collect firewood. We also note that the average time to collect firewood at the household level, increased by 14 percent between 2004 and 2011. However, the distance of the ward to the forest appears to have decreased. This may be interpreted as an improvement of the forest conditions in 2011 relative to 2004 as it may mean that forests partly regenerated and are now closer. In addition, the increase in collection times may also be consistent with the presence of FUGs in the villages which has imposed restrictions in access to the forests. Finally, there is a higher proportion of wards where trees have been planted by the community relative to those planted by the government or privately in both surveys. This also testifies to the role of FUGs in these villages. A lower proportion of households seem to have trees planted by the community or privately in 2011 relative to 2004. This may either indicate that the forests are in better condition and hence there is less need to replant trees or it can indicate that less efforts are put toward forest regeneration. Both interpretations are equally valid. Recent forest estimates of Nepal appear to show that despite forest conditions deteriorating in the past two decades, between 2005 and 2010 the total forest cover remained constant (FAO, 2010b). This is an indication that, if anything, at least the forest conditions did not deteriorate over this period.

2.5 Empirical strategy

Our empirical strategy is divided into three parts. We first look at the determinants of female participation in Executive Committees. We then look at the relationship between such participation and firewood collection which is the objective of our analysis. Finally,

not been able to obtain these data for the current analysis and have to rely on the available data to account for forest conditions.

in order to account for the potential endogeneity of the proportion of women in the ECs of FUGs, we use a difference-in-difference estimation strategy to identify the effect of an increase in the participation of women on firewood collection.

2.5.1 Determinants of female participation in Executive Committees

We first look at which variables determine female representation in ECs of FUGs as we want to understand what drives their participation. We regress the village average percentage of women in ECs of FUGs on a set of household and village characteristics and on a set of FUG related characteristics. We estimate the following specification using an OLS model:

$$Women_{jdt} = \alpha + X'_{hjdt}\beta + F'_{jdt}\gamma + distr_d + distr_d * nlss2011_t + yform_{jt} + u_{jdt} \quad (2.1)$$

The term on the left hand side, $Women_{jdt}$ is the average percentage of women in ECs of FUGs formed in village j of district d up to year t. This variable ranges from 0 to 1 and is calculated as the village average percentage of women in ECs of FUGs formed in all years up to 2004 or 2011 depending on whether the village had been sampled in one or the other year.[26]

The term X_{hjdt} represents a set of household characteristics for household h living in village j of district d surveyed in year t. F_{jdt} are village characteristics and village level FUGs related characteristics. Specifically, we include some variables which account for forest conditions. As we might expect that female participation also depends on the economic condition of the village we also include the percentage of high caste households in the community. However, this variable may also control for social norms whereby low

[26] As already explained in the data section there is some missing information on the percentage of women variable and this explains the different number of observations used in this analysis and in the one reported for the following section.

caste groups are less subject to norms that hinder female participation at various levels within a society (Agarwal, 2001). We include dummies for whether there are user groups other than FUGs in the ward and whether there are development projects. We would expect these variables to be positively correlated with the presence of women on the ECs of FUGs if these projects are devoted to women empowerment issues. Finally, we include the average number of FUGs in the village, the village average area of forest handed over to FUGs and the village average number of household members of FUGs.

We also include district fixed effects, $distr_d$ and $distr_d * nlss2011_t$, to account for any difference across districts and a set of village level dummies which control for the year of FUGs formation, $yform_{jt}$. We assume the error term u_{jdt} to be independent between villages. As we expect observations within each village to be correlated, we cluster the standard errors at the village level. We also estimate robust standard errors to account for heteroscedasticity of the error terms.

We need to note that there can be unobservable characteristics which may affect both female participation and village, household or FUG characteristics. For example, the degree of awareness on issues related to female empowerment at the local level is typically unobserved. This can be positively correlated both with the presence of development projects or other user groups with a specific focus on women issues and the percentage of women in the ECs of FUGs. The resulting estimates are potentially upward biased. Therefore, this analysis should provide information on the correlations between female participation and some village, household and FUG characteristics. We do not interpret these estimates as causal effects of any particular characteristic on female participation. However, this analysis provides a useful basis and organising framework for the subsequent analysis and discussion.

2.5.2 Female participation in Executive Committees and firewood collection

The objective of our analysis is to examine the effect of an increase in female participation in the ECs of FUGs on firewood collection at the household level. Therefore, we are interested in estimating the following specification:

$$Y_{hjdt} = \alpha + \beta Women_{jdt} + X'_{hjdt}\delta + F'_{jdt}\gamma + distr_d + distr_d * nlss2011_t + yform_{jt} + e_{hjdt} \quad (2.2)$$

where Y_{hjdt} is the outcome of interest (i.e., quantity of firewood at the household level) for household h living in village j of district d and surveyed in year t. $Women_{jdt}$ is defined as in the above section and β is the estimated coefficient of interest. We include household and village characteristics, FUG related charactericts, district fixed effects and dummies which control for the FUG's years of formation which are defined as in equation (2.1). As with the estimation of equation (2.1) we assume the error term e_{hjdt} to be independent between villages but not necessarily within villages. As we anticipate observations within each village to be correlated and potentially not robust to heteroscedasticity, we estimate robust standard errors and cluster them at the village level. The above equation is estimated using an OLS model.

The percentage of women on the ECs of FUGs may not be exogenous to the outcome. Indeed there may be unobserved characteristics which could predict both female participation in ECs of FUGs and firewood collection. This may lead to biased estimates of equation (2.2). A higher participation of women in ECs of FUGs may reflect systematic characteristics of villages where the FUGs have been formed which may also have affected firewood collection. Estimates from equation (2.1) above should give us some insights on what characterises village level female representation in ECs of FUGs. However, we are only able to inform on observed characteristics. Other unobservables could have also

jointly determined female participation and firewood collection. One example of a potentially unobserved characteristic is the level of social capital within the village which may imply a general positive gender attitude accompanied by a higher awareness toward forest conservation (Agarwal, 2009a). We expect this to be positively correlated with the presence of women in the ECs of FUGs but negatively correlated with firewood collection if higher social capital changes also the attitudes toward forest protection and ultimately toward firewood collection in a way that people collect less. OLS estimates may therefore be downwardly biased if this unobservable is ignored. In order to address the potential endogeneity of female participation in ECs, we need a source of exogenous variation in the percentage of women in ECs of FUGs. The next section is devoted to addressing this issue.

2.5.3 Difference-in-difference empirical strategy

In this section we propose one way to address the potential endogeneity of the female participation variable. In order to identify the causal effect of an increased representation of women in the Executive Committees of FUGs on firewood collection, we exploit the introduction in 2009 of the new guidelines and the fact that we can observe the outcomes before and after this change (i.e., in 2004 and in 2011).

Our identification strategy is based on the observation that the 2009 FUGs new operational guidelines, by including a new specific provision for female representation in the ECs (i.e., at least 50 percent of women should be part of the ECs),[27] increased substantially the proportion of women in groups formed after 2009 (see Figure 2.1). As a remark, we are not claiming here that groups formed after 2009 have 50 percent of women in the ECs of FUGs. We are only stating that as a result of the introduction of the new guidelines in 2009, which put more emphasis on female representation in these institutions, the percent-

[27] See section 2.3.

age of women actually increased in groups formed after this date. Tables 2.2 and 2.A.6 are also consistent with this pattern.

We exploit this source of variation for our identification strategy. The estimation framework that we propose follows a difference-in-difference (DD) identification strategy.[28] More specifically, we compare the change in outcomes between 2004 and 2011 for households living in villages where some FUGs formed after the introduction of the new guidelines in 2009 (treated villages) to the change in outcomes over the same period for households living in villages where FUGs formed only before 2009 or in 2009 (control villages). As both treated and control villages include at least one FUG formed since the start of the programme in 1993, these villages should be comparable in many of their relevant characteristics. Therefore, the first difference compares treated to control villages. Villages in the control group are those that have formed FUGs in 2009 or in the years preceding the introduction of the new guidelines but none after 2009. While villages in the treatment group have formed FUGs after 2009 but could have also formed FUGs before. Thus, all villages in the sample may have formed FUGs in various years since the start of the programme in 1993. What distinguishes the treated villages is the fact that these villages may have *also* formed FUGs after 2009 and this is what allows us to define them as treated villages. According to our sample the percentage of treated villages is 16 percent, corresponding to 532 households out of 3,252 and to 47 villages out of 293. The second difference comes from comparing the outcome before (i.e.,2004) and after (i.e.,2011) the policy change. This allows us to control for systematic differences between treatment and control groups.

The baseline difference-in-difference specification, that we estimate using an OLS

[28] We are aware that other methodologies could have been employed to address a potential endogeneity problem of the variable of interest (e.g., Instrumental variables, Regression Discontinuity Design or Propensity Score Matching). However, given the available information and data, we believe that a difference-in-difference estimation strategy would suit better the purposes of this analysis.

model, is of the following form:

$$Y_{hjdt} = \alpha + \beta after2009_j + \gamma nlss2011_t + \delta(after2009 * nlss2011)_{jt} + \epsilon_{hjdt} \quad (2.3)$$

Where Y_{hjdt} is the outcome of interest (i.e., quantity of firewood collected) for household h living in village j of district d and surveyed in year t. The variable $after2009_j$ is a dummy which equals 1 if in the village FUGs were formed also after 2009 (so in 2010 and 2011) and 0 if FUGs were formed only before 2009 or in 2009. The $nlss2011_t$ variable is a dummy equal to 1 for 2011 NLSS observations and 0 otherwise. ϵ_{hjdt} defines the error term. The parameter δ is the reduced-form estimate of the effect of an increase in female participation on firewood collection (i.e., the DD coefficient). Our hypothesis is that firewood demand would decrease as a result of an increased representation of women in the ECs. We test if this is present in the data.

The underlying assumption of the identification strategy is that trends in firewood collection would have been the same in both treatment and control groups in the absence of the treatment (i.e., the treatment induces a deviation from the common trend). Indeed the existence of omitted factors correlated to both whether villages formed groups after 2009 and firewood collection, would represent a threat for our strategy. In order to account for time-invariant differences in firewood collection levels across districts we include district fixed effects. We also include district fixed effects interacted with the NLSS 2011 dummy to allow for any difference between districts for 2011 and 2004 observations. These should account for much of the time-variant unobserved heterogeneity at the district level. The inclusion of district fixed effects accounts among other things for differences in conflict intensity across Nepal over the years. Unfortunately, we do not have information on conflict exposure at a lower level than the district. However, in our sample there are, on average, three villages per district and villages are well spread across districts. Therefore, we are

confident that by including district fixed effects we are accounting for most of the conflict exposure. District fixed effects should also account for donor presence. Traditionally, donors have focused their interventions at the district level (Edmonds, 2003).

However, pre-existing differential trends in firewood collection could still explain part of the results. In order to account for differences between districts over time, we should include district level trends. However, as we had to collapse the FUG census data at the village level, we do not have any variable that permits us to specify a trend. As an alternative to the inclusion of district specific trends to account for the possibility of time varying confounders, we have conducted a series of placebo experiments which we will discuss in a later section. The results from these experiments are reassuring for the validity of our identification strategy.

As discussed in previous sections, villages which formed groups in earlier years just after the reform of 1993 may be quite different from those that formed groups in more recent ones. To account for these differences, we control for whether a village formed at least one FUG in a particular year from 1993 up to 2011. We include therefore one dummy for each year of formation. We also control for the total number of FUGs formed in each village, for the village average area of forest handed over to FUGs and for the village average number of households members of FUGs.

Finally, we also estimate a specification that includes a set of other village and household controls as in equation (2.2). The inclusion of these terms besides increasing precision in our estimates should also account for as much observed heterogeneity of households and villages as possible.

The *richest* specification we estimate is therefore defined as follows:

$$Y_{hjdt} = \alpha + \beta after2009_j + \gamma nlss2011_t + \delta(after2009 * nlss2011)_{jt} + \tag{2.4}$$

$$distr_d + distr_d * nlss2011_t + yform_{jt} + X'_{hjdt}\theta + F'_{jdt}\gamma + \epsilon_{hjdt}$$

Where all terms are defined as in previous equations. Specifically, $distr_d$ are district fixed effects, $distr_d * nlss2011_t$ are district-specific effects for each survey year, $yform_{jt}$ are a set of village dummies that equal one if in village j surveyed in year t at least one FUG was created in a particular year between 1993 and 2011. Finally, X_{hjdt} are household characteristics. F_{jdt} are village characteristics and FUGs characteristics at the village level. We assume the error term ϵ_{hjdt} to be independent between villages but not necessarily within villages. As we expect observations within each village to be correlated and not necessarily robust to heteroscedasticity, we estimate robust standard errors and cluster them at the village level.

2.6 Results

The next three sections report the results from the estimates of the specifications outlined above.

2.6.1 Estimates of determinants of female participation in ECs of FUGs

We present in Table 2.4 results from the analysis of the determinants of female participation. The dependent variable measures the village average percentage of women in ECs of FUGs.[29] The results provide some interesting information on what correlates with the village average female participation in ECs of FUGs. The household size is positively correlated with the village level participation in ECs. We have decomposed the household size variable[30] into number of children, male and female adults in the household. Although the signs are all positive, only the coefficients on female adults remain statistically significant. This is suggestive that the presence of more women in the household allows some of them

[29] As the variable is bounded between zero and one, we check from our estimates that the predictions of this variable do not fall below zero or above one. We find that none of the observations is outside this range.

[30] Results not shown but available upon request.

to take up household work freeing others who are then able to participate in the FUGs. To note that none of the variables related to the household head (i.e., gender, age, migration and education of the household head) seem to be correlated with village average female participation. Agarwal (2001) argues instead that household attributes and endowments play an important role in determining the participation of women in groups. We note that both the number of livestock and the hectares of land owned or cultivated are negatively correlated with female representation in the ECs of FUGs. Also a lower distance of households from the paved road relative to a higher distance is associated with a lower percentage of women in ECs of FUGs. The coefficient on firewood collection in community forest areas is not significant. Instead the village average participation of women in ECs is lower for households who collect in government forest relative to their own land. This may suggest that, while controlling for household size, collecting firewood in government forest may require more time than in private land. As a result on average less women in the village would be available to take up roles within the ECs of FUGs. The greater the distance of the community to the forest the higher the average female representation in ECs. This variable should reflect both the forest condition and the opportunity cost of collection of forest products. In both cases, poorer forest conditions and a higher opportunity cost of collecting forest products, may push women to more actively participate to the protection of the forests, if their concerns are at risk. These estimates appear to suggest that female participation is higher in villages which are on average less advantaged than others. Also, the higher the proportion of existing user groups other than forestry ones in the village, the lower the percentage of women in ECs. As the presence of user groups of various types is usually more prevalent in better-off and more accessible villages (Edmonds, 2002), this result is an additional indication that female participation seems to be higher in worse-off villages.

These results are somehow surprising as we would have expected that female particip-

ation in ECs of FUGs would be higher in groups formed in villages that are on average richer and more accessible and where the presence of alternative user groups other than forestry would have potentially increased awareness among women that would in turn be more prone to participate in groups. Additional insights come from the observation that female participation is negatively associated with the village average area of forest handed over to FUGs and to the village average number of households in FUGs. This is consistent with our finding in Section 2.4 where we showed that the percentage of women in the ECs of FUGs is decreasing in the area of forest handed over and in the number of household members of the FUG. We also noted that the area of forest is substantially lower for groups which have one hundred percent of women in the EC. The existing literature suggests that typically women-only groups receive more degraded forest and smaller areas of forest than mixed groups (Ray-Paudyal and Buchy, 2004; Agarwal, 2010b). However, the effectiveness in terms of forest management and protection of women-only groups or groups where a female presence is dominant relative to men is mixed. Recent studies reveal that all-women groups, despite receiving more degraded forests and smaller areas, are found to have better outcomes in terms of forest conservation (Agarwal, 2009a). However, recent research has also reported that groups where women are dominant are less effective than other groups in forest management practices (Mwangi et al., 2011). In order to shed more light on this and other aspects that characterise female participation in the ECs of FUGs, we should have FUGs related characteristics at the household level. For example, knowing not only the gender but also the caste, the education level and the age of the EC members at the household level (Agarwal, 2009a), would inform better on heterogeneities within CFUGs.

2.6.2 Female participation in ECs of FUGs and firewood collection estimates

We present the results on the estimation of equation (2.2) above in Table 2.5. The results do not show any significant correlation between female participation in ECs of FUGs and firewood collection. Indeed, despite exhibiting a negative sign, none of the specifications yield coefficients on the village average percentage of women in ECs significantly different from zero. Therefore, these estimates seem to indicate that a higher female participation in ECs of FUGs is not related to household firewood collection. The lack of any correlation between the participation of women and firewood collection may be due to the fact that a higher percentage of women in the ECs of FUGs does not necessarily imply that they have a higher decision making power and consequently that they are able to affect outcomes (Agarwal, 2010a). A recent study does not find any persistent effect of increasing female representation on their participation in local decision making (Casey et al., 2012). A possible explanation lies in the fact that communities may be pushed toward more inclusion without actually challenging the elites who hold power (Acemoglu and Robinson, 2008). However, we should consider this result with caution for now because, as explained, we are ignoring here the potential endogeneity problems of female participation in FUGs. The reported estimates might indeed be biased.

The coefficients on the other variables included in the specification provide some insights on what correlates to household firewood collection. Our results are mostly consistent with Baland et al. (2013) and Baland et al. (2010b) who analyse the determinants of firewood collection and specifically the effects of increasing living standards on forest degradation. They suggest that an increase in consumption raises firewood collection. However, they also specify that the sources of growth matter. In particular, the wealth and substitution effects have to be distinguished to clearly establish in which direction an improvement of the economic conditions affects firewood collection and thus environmental

degradation. Column 5 of Table 2.5 reports results which include a set of controls that try to account for the economic conditions of the households and their remoteness.[31] We also include some village level characteristics which should control for forest conditions in the year of the surveys, whether the village had natural disasters, the proportion of high caste in the village, the presence of other user groups and of development projects. These two latter variables should control for the accessibility of the village to donors and NGOs. Finally we include some FUGs characteristics.

Household size is positively associated with firewood collection. This suggests that as household size increases, the demand for firewood is higher as there is an increasing need within the household for firewood. This may also suggest that an increasing number of persons in the household, lowers the opportunity cost of firewood collection as more individuals in the household are available for this task. We have decomposed the household size variable between number of children, male and female adults (results not shown). The coefficients on these terms all remain positive and significant with the biggest size of the coefficients reserved for female adults. This is consistent with the fact that women are those mostly responsible for firewood collection within the household.

Also a higher level of education of the household head relative to having no education decreases firewood collection. This may be consistent with the idea that, controlling for other sources of wealth, more educated households should be more concerned about forest degradation and hence collect less. On the other hand, households which own more livestock and more hectares of land collect a higher quantity of firewood. Baland et al. (2013) also show that an increase in livestock is associated with an increase in the quantity of firewood collected. The positive sign on the livestock coefficient reflects both the fact that livestock is a source of wealth (positive income effect) and the fact that livestock

[31] We are not including household consumption as a measure of wealth of the household not only for its potential endogeneity but also because its inclusion does not allow to assess the effects of different sources of wealth and opportunity.

is also a productive asset, which is thus complementary to firewood collection (grazing). These two effects unambiguously generate an increase in firewood collection. The positive effect on land may suggest a prevailing wealth effect. Households which use electricity as a light source collect more firewood. The availability of electricity should partly reduce the dependency on firewood. Hence these households may have less concerns over forest protection and demand more firewood. Alternatively it captures an income effect whereby as households become richer they consume more firewood.[32] A higher distance of the village to the forest is negatively correlated with the quantity of firewood collected at the household level. This is consistent with the fact that if forests are more distant, people would collect less as the opportunity cost of collecting is higher. Alternatively, larger distance to the forest may simply reflect more depleted forests which still would decrease firewood collection. A higher percentage of high caste households in the community decreases firewood collection. This is partly consistent with Agarwal (2001) who finds that a higher percentage of high caste (i.e., Brahmins) members in the ECs improves forest conditions. Finally, a higher number of FUGs in the village and a higher average area of forest transferred to the FUGs is associated with more firewood collection. This may suggest that the presence of more FUGs and larger areas of forest distributed may have rendered firewood more available. Hence, households can thus extract more firewood.

These results offer some interesting insights on the determinants of firewood collection which are mostly consistent with other findings in the literature (Baland et al., 2013). We exploit part of this evidence in the final part of this analysis. These estimates do not show a significant relationship between the participation of women in the ECs and firewood collection. As mentioned above, this result may also be driven by the fact that in the empirical strategy we have ignored the potential endogeneity of female participation. The

[32]These explanations, consistently with the findings of Baland et al. (2013), would be in contrast to the Poverty Environment Hypothesis which predicts that an increase in wealth should be associated with a decrease in deforestation.

next section shows results from a difference-in-difference estimation strategy that tries to address this issue.

2.6.3 Difference-in-differences estimates

Before presenting the results from the estimation of equations (2.3) and (2.4), we look at household, village and FUG characteristics for both control and treament groups in the pre-treatment year (the 2004) and test the differences in means (Table 2.6). This allows us to check whether the characteristics of these groups were broadly similar before the policy change. As explained earlier we include in our treatment group villages which formed FUGs in any year from 1993 up to 2011. Villages in the control group include villages which formed FUGs from 1993 up to 2009 only. The results in table 2.6 show that some characteristics are significantly different between treatment and control groups. These results can be a concern for our identification strategy as we would have expected the average characteristics to be similar between treated and control groups in the year preceding the policy change. However, although a large degree of similarity between treatment and control villages in the pre-treament year would have been more reassuring for the validity of our identification strategy, we need to note that those shown in Table 2.6 are differences in the *levels* of the characteristics of treated and control villages in the pre-treatment year. In order for our identification strategy to be valid we need the differences in *trends* to be zero. We will show in the next section results from placebo experiments which suggest that this is indeed the case.

We report the results from our difference-in-difference estimates in table 2.7. The coefficient on the DD term (δ) is negative and significant across all specifications. Despite altering across specifications, the magnitude remains broadly invariant to the addition of more controls. These results tell us that between 2004 and 2011, the firewood collection of households living in villages which formed FUGs also after 2009, decreased on average by

21.4 bharis per year, as compared to those living in villages which formed FUGs only before or in 2009. As one bhari is a headload of firewood, the results suggest that this effect is quite large. If we think that one headload can be one round trip, this corresponds to a bit more than 20 round trips. In order to give an interpretation of the results in percentage terms, we divide the DD coefficient of column 5 by the average firewood collection in the control villages in the pre-treatment year (i.e., in 2004) which is 90 bhari per year. The decline in household firewood collection is on average 24 percent, which represents a substantial reduction. These results therefore indicate that in villages where FUGs have a higher percentage of women in the ECs, household firewood collection decreases sharply. We recall from Table 2.5 that the coefficients on the participation of women are not statistically significant from zero. Therefore, ignoring the possibility that there could be unobservables which may correlate with both the percentage of women in ECs of FUGs and firewood collection, would lead to downwardly biased estimates as argued in Section 2.5.2.

It is interesting to note that all other explanatory variables in column 5 of Table 2.7 are very similar in signs, significance and magnitude to those in Table 2.5. Indeed, coefficients on household size, electric light source, hectares of land owned or cultivated and number of livestocks owned are all positive and significant. While those related to the household head's education, the distance of the community to the forest, the percentage of high caste in the ward are all negative and significant. Finally, also the signs on the FUGs related characteristics are the same as in Table 2.5. This, as mentioned, may suggest that the presence of more FUGs and larger areas under their management enable households to collect more firewood.

In summary, these results seem to indicate that an increase in female participation in the ECs of FUGs decreases household's firewood collection, which is consistent with our hypothesis. Hence a higher percentage of women in decision-making position seem to

prioritise sustainable extraction and thus forest conservation to satisfy their daily needs. We discuss further these results in section 2.7.

2.6.4 Robustness and validity checks: placebo tests

Our identification strategy is valid only if trends in firewood collection were parallel before 2009. We have tested the validity of our identification strategy through a set of placebo tests.

In a first set of placebo experiments we estimate the same DD specification as outlined in equations (2.3) and (2.4), defining treated villages as those that are not part of our original treatment villages (i.e., villages in which no FUGs were formed in 2010 and 2011). Hence we still compare the change in outcomes between 2004 and 2011 between households living in villages where FUGs were formed only *before* the introduction of the new guidelines in 2009. Some of these villages are defined as placebo treatment villages and some as control. None of them should have experienced any policy change in terms of female representation in the ECs. If we find that the coefficients on the placebo DD terms are not significantly different from zero, we may conclude that there was no pre-treatment trend in firewood collection systematically correlated with subsequent female participation in ECs of FUGs. This would therefore reassure on the validity of our identification strategy.

Specifically, we have constructed four different placebo treatment groups by progressively excluding villages that formed groups in more recent years. The first placebo treatment group includes villages which have formed FUGs in 2008 and 2009. The control group includes villages which have formed groups only before 2008. Villages which have formed FUGs in 2010 and 2011 (our actual treatment group) are excluded from the sample. The second placebo group includes villages which have formed groups in 2007 and 2008 and the control includes those formed only before 2007. The third placebo group includes

villages that formed FUGs in 2006 and 2007 and the control group includes villages which have formed groups only before 2006. Villages which have formed FUGs in 2008 or in later years are excluded from the sample. Finally, the fourth placebo treatment group includes villages which formed FUGs also in 2005 and 2006 and the control is comprised of those formed only before 2005. All other villages which formed groups in later years are excluded from the sample.

We have estimated the same specifications as in equations (2.3) and (2.4) for all regressions. The results are shown in Table 2.8. We do not report the coefficients on other control variables as in the main regression results, as the signs and significance are very similar and do not provide any additional information. One remark is the decreasing number of observations as we gradually exclude villages from the sample. The results show that none of the coefficients on the placebo terms (in the specification that includes all controls) is statistically significant with the exception of column 5 of Panel B where the coefficient on the DD term is significant at the 10 percent. These results are quite reassuring for our identification strategy. They suggest that by looking at the same change in firewood collection between 2004 and 2011 but comparing villages that did not actually experience any treatment (i.e, did not form any FUG after 2009), no pre-treatment differentials in trends in firewood collection were dectected.

In order to further test the validity of our strategy we implement an alternative placebo test. For this purpose we make use of the 1996 NLSS survey and drop the 2011 NLSS from this analysis. Basically we compare the change in outcomes between 1996 and 2004 for households living in villages where some FUGs formed after 2009 to the change in outcomes over the same period for households living in villages where FUGs formed only before 2009. So here we look at the change across two years during which there has not been any policy change in terms of female participation in FUGs while mantaining the original treatment and control groups. Indeed, the treated and control villages remain the

same as in our specifications of equations (2.3) and (2.4). The results in Table 2.9 show that the point estimate for the placebo interaction term is positive but not significantly different from zero.

2.7 Discussion of the results

Our estimates from the difference-in-difference model, indicate that an increase in female participation in the ECs of FUGs, identified by villages where groups formed also after 2009, decreases household's firewood collection. A higher presence of women affects the decision making process within the ECs of FUGs in a way that limits firewood extraction and ultimately improves forest conservation and regeneration. Women sitting on the ECs seem to prioritise forest conservation to ensure the satisfaction of their daily need for firewood. The mechanisms through which a higher presence of women in the ECs may affect the quantity of firewood collected at the household level are various. The presence of more women may condition the choice of stricter or more lenient rules which define the access to forests and the extraction of firewood (Agarwal, 2009a). The quality of protection may improve, hence limiting rule violations. A higher female participation may also facilitate the spread of information around the community and hence render women more cooperative and empowered and ultimately more concerned about forest conservation. Unfortunately, our data do not allow an exploration as to which of these mechanisms plays a bigger role.

We discuss here reasons that support our explanation of these results. First, for a given effect that the presence of FUGs may have already had on the forests, the effect we are identifying should only relate to the change in female participation in the ECs of FUGs. As our sample includes only villages which have formed at least one FUG at some point in time, we are able to control for any effect that these institutions may have had at the local level. The extent of these effects is accounted for by the inclusion of the year of

formation of all FUGs created in the villages in our sample. Second, our results also hold when controlling for both the quantity of forest under the FUG managament (i.e., the area of forest transferred) and the quality of the forest (i.e., forest conditions). The area of forest that FUGs manage informs on the amount of land which users can dispose of and hence partly control for the supply of forest products. Holding the number of households members of FUGs constant, the bigger the area the higher the products available. Indeed, we obtain a positive sign on the coefficient that controls for area of forest transferred. In addition, we control for forest conditions including the variables that inform on whether the forest decreased in the past five years and whether the time to collect firewood increased in the past five years. We already acknowledged that these variables may capture forest conditions in an imprecise way, but believe that they partly control for the quality of the forests. In addition, the distance of the community to the forest captures not only the opportunity cost of collecting firewood but also forest conditions. The more degraded the forest, the lower the amount of firewood that can be collected.

However, there is still the possibility that forest conditions and the area of forest under FUG management are not adequately controlled for. There could be an unobserved portion of these characteristics which is correlated with both female participation and firewood collection. The resulting estimates would be biased and would not reflect a causal effect of an increase in the representation of women in the ECs of FUGs on firewood collection. In Section 2.4 we acknowledged a negative correlation between the area of forest and female participation in ECs of FUGs and showed also that the average area of forest transferred is substantially lower for groups which have one hundred percent of women in the ECs. The existing literature suggested that these groups have been traditionally allocated smaller areas of forest which were also more degraded. Therefore, a higher presence of women in the ECs of FUGs may simply reflect smaller and more degraded forests. As a result of this, firewood collection would decrease simply because the supply of forest products is

lower. Hence, if the percentage of women is negatively correlated with the area of forest handed over and the expected sign on the area coefficient is positive (i.e., an increase in the area positively correlated with firewood collection), our estimate can be downward biased if part of this variation is left unexplained. Therefore our estimates, if biased, represent a lower bound of the true effect. Similarly, we expect also a downward bias in our estimates if we are not controlling properly for forest conditions (i.e., the quality of the forest). Indeed, we expect a negative correlation between forest condition and female participation and a positive coefficient of forest condition on firewood collection as better forest condition would lead to a higher demand for firewood. Nonetheless, as the percentage of groups with a dominant presence of women is small, we argue that the potential bias should be small in this case.

Finally, the results from the analysis of the determinants of female participation in the ECs of FUGs seemed to suggest that women were more represented in the ECs of FUGs of villages where households were on average worse-off. Hence our results may simply reflect these worse conditions. However, and in support of our explanation, by including various household and village characteristics we should control for their economic status which would reflect in the demand for firewood. Our results are invariant to the inclusion of these types of variable.

2.8 Concluding remarks

This essay looks at the effects of an increase in female participation in the ECs of FUGs on household firewood collection in Nepal. The study is motivated by the observation that women are often neglected in the decision-making process within community level institutions devoted to the management of natural resources. However, women have a fundamental role in the management of environmental resources and forestry in particular.

We address the potential endogeneity of female participation exploiting the 2009 new

provision for female representation in the EC of FUGs. This change in the guidelines increased the share of women in the ECs of groups formed after 2009. The results from our difference-in-difference model show that an increase in the average village level participation of women in ECs of FUGs, identified by villages where groups formed also after 2009, decreases the collection of firewood at the household level. This result is suggestive that women are prioritising conservation and hence once in a decision-making position they favour decisions which tend to ensure a sustainable extraction of firewood. This important finding suggests that a greater focus should be put on the role of women in forestry and in general in collective action institutions.

We believe that with the available data we have done our best to rigorously answer our research question. However, more detailed data would offer further insights for the analysis. We do not know whether a specific household is a member of a certain FUG or not. Therefore, we are not able to account for heterogeneity between households who are members of FUGs or not. In addition, as FUGs related data are collapsed at the village level and as this is the level at which we can merge the information on the household survey, we loose variation in the FUGs data which could serve to exploit groups heterogeneity. The availability of data on FUGs membership at the household level would be a step forward allowing us to provide more insights on the effects of female participation in ECs on firewood collection. Furthermore, our focus is on household firewood collection which is one possible cause of forest degradation. Data on alternative measures of forest conditions would be useful to explore and enable us to offer a comprehensive answer to our research question. Finally, we do not have data that could enable us to explore the mechanisms through which a higher female participation in the ECs affects the decisions. Additional information on these aspects would be insightful for this analysis.

Notwithstanding the above remarks, the current analysis makes important contributions to this largely ignored, though extremely relevant, topic. The recognition of a role for

women within local collective action institutions may improve the outcomes of community groups in terms of their effectiveness for the protection and management of the resource. We try to account for the potential endogeneity of female representation within CFUGs which no other analysis to our knowledge has tried to address. This is also the first study that examine the role of gender within collective action institutions looking at a vast area of Nepal, using nationally representative household surveys and linking these to a unique census of FUGs.

We deem this topic and our research question extremely important not only for the specific setting of Nepal but for any developing country which has some natural resources to manage and protect and which are essential to the daily lives of people. Our results indicate indeed that in countries with common property resources, the effectiveness of collective action institutions depends also on which provisions are made for the functioning of these groups, specifically in terms of the gender composition of the decision-making bodies.

Figures

Figure 2.1: Percentage of women in ECs of FUGs by year of FUGs formation

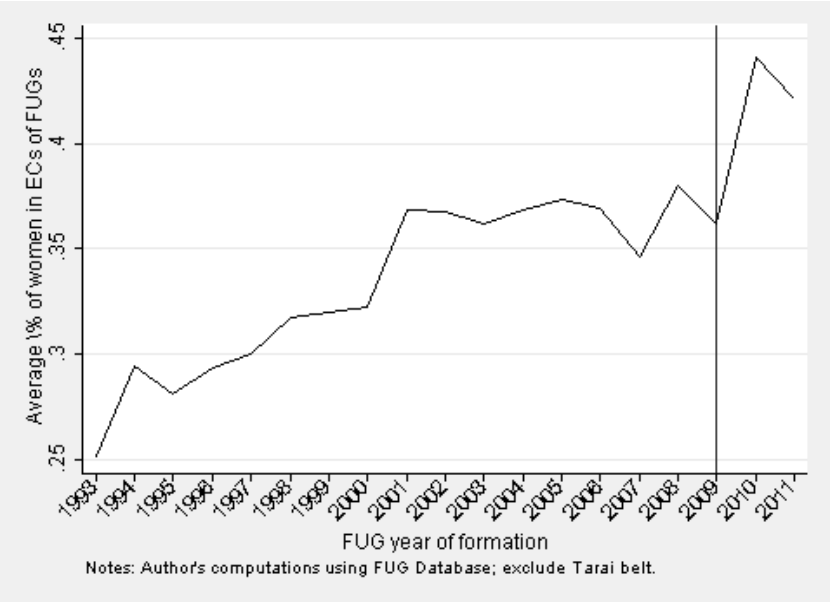


Figure 2.2: Number of new FUGs by year of FUGs formation

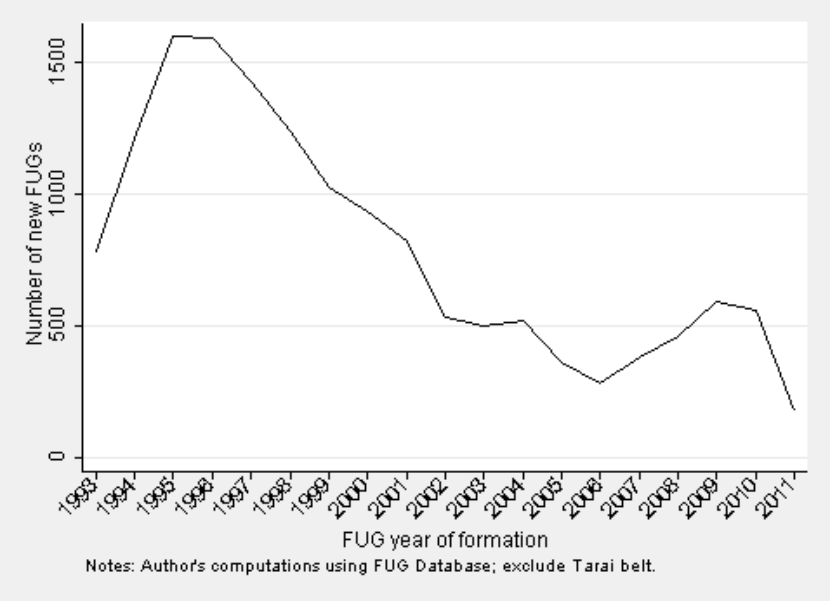


Figure 2.3: Total new area of forest handed over by year of FUGs formation

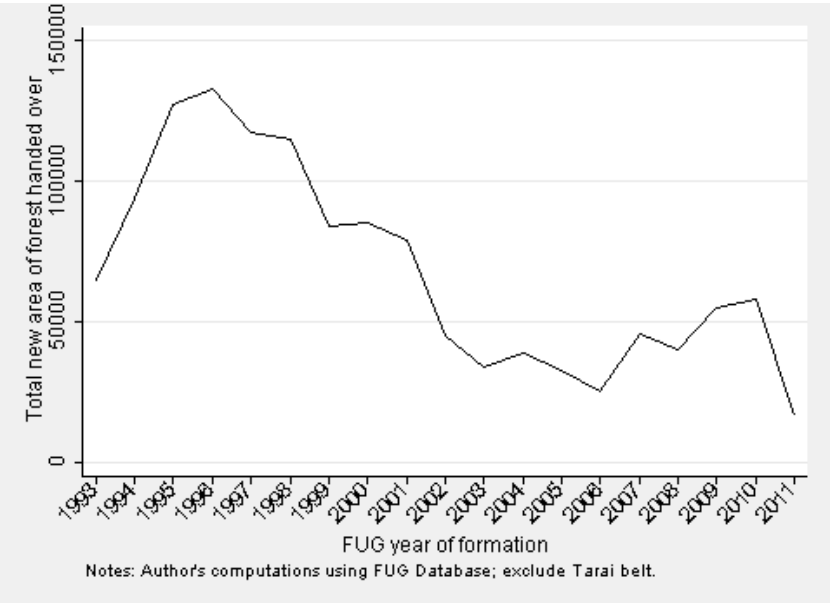


Figure 2.4: Total new number of households in FUGs by year of FUGs formation

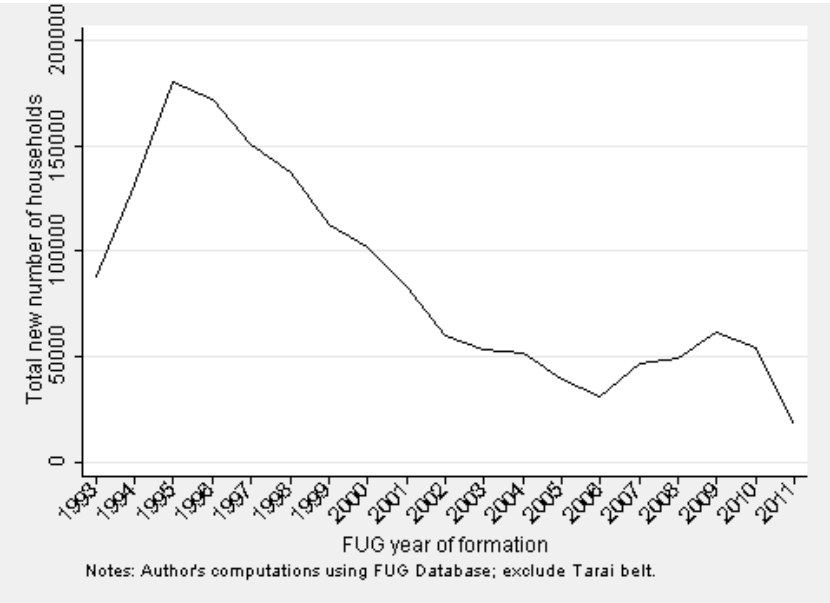
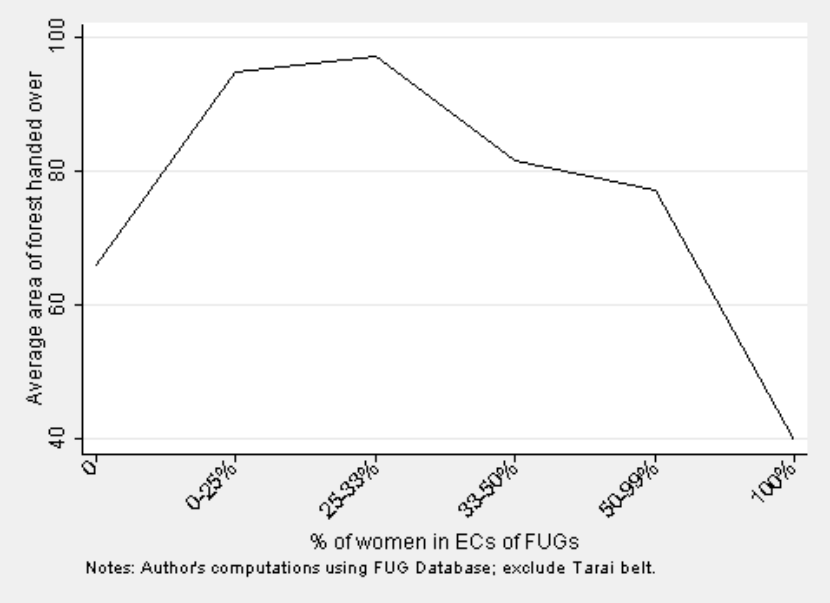


Figure 2.5: Percentage of women in ECs of FUGs and area of forest handed over



Tables

Table 2.1: FUGs characteristics - Census data

	Obs.	Mean	St.Dev.	Min	Max
Eastern region	17685	0.175	0.380	0	1
Central region	17685	0.223	0.416	0	1
Western region	17685	0.261	0.439	0	1
Mid Western region	17685	0.216	0.412	0	1
Far Western region	17685	0.125	0.331	0	1
Mountains	17685	0.142	0.349	0	1
Hills	17685	0.743	0.437	0	1
Tarai	17685	0.116	0.320	0	1
Forest handed over (Ha)	17675	92.144	164.542	0	5698
Number of households in the group	17660	123.322	148.858	0	4690
Number of EC members	17181	11.584	2.747	0	39
Percentage of women in EC	16108	0.333	0.226	0	1

Notes: Author's computations using FUG Database.

Table 2.2: Average percentage of women in ECs of FUGs - Census data

	All	1993-2000	2001-2006	2007-2009	2010-2011
% women in ECs=0	0.018	0.023	0.009	0.009	0.008
% women in ECs between 0-25%	0.396	0.474	0.310	0.230	0.117
% women in ECs between 25-33%	0.182	0.177	0.188	0.225	0.141
% women in ECs between 33-50%	0.271	0.213	0.332	0.410	0.454
% women in ECs between 50-99%	0.078	0.066	0.081	0.071	0.212
% women in ECs =100%	0.056	0.046	0.080	0.056	0.068
Observations	13814	8747	2922	1420	725

Notes: Author's computations using FUG Database; Exclude Tarai belt.

Table 2.3: Summary statistics for rural household and village characteristics

	2004				2011			
	Mean	St.Dev.	Min	Max	Mean	St.Dev	Min	Max
Quantity firewood collected (Bhari/year)	91.007	52.424	12	360	83.555	60.599	0	600
Time to collect firewood (Hours/bhari)	3.471	1.669	0	12	3.910	1.876	1	10
Use firewood past 12 months	1.000	0.000	1	1	1.000	0.000	1	1
Collect firewood past 12 months	1.000	0.000	1	1	1.000	0.000	1	1
Collect firewood in own land	0.270	0.444	0	1	0.257	0.437	0	1
Collect firewood in community forest	0.345	0.476	0	1	0.468	0.499	0	1
Collect firewood in government forest	0.342	0.475	0	1	0.234	0.424	0	1
Collect firewood in other forest	0.043	0.203	0	1	0.041	0.198	0	1
Electric light source	0.216	0.412	0	1	0.481	0.500	0	1
Gas,Oil,Kerosene light source	0.681	0.466	0	1	0.309	0.462	0	1
Use firewood as cooking fuel	0.971	0.167	0	1	0.964	0.186	0	1
Use dung/leaves as cooking fuel	0.005	0.071	0	1	0.005	0.068	0	1
Gas,Oil,Kerosene as cooking fuel	0.024	0.152	0	1	0.031	0.174	0	1
HH size	5.109	2.219	1	17	4.823	2.144	1	15
HH head female	0.227	0.419	0	1	0.283	0.451	0	1
HH head married	0.835	0.371	0	1	0.860	0.347	0	1
HH head age	46.336	14.650	14	91	47.070	14.461	14	95
HH head migrated	0.317	0.466	0	1	0.259	0.438	0	1
HH head any compl edu	0.656	0.475	0	1	0.558	0.497	0	1
HH head completed primary education	0.167	0.373	0	1	0.239	0.426	0	1
HH head completed secondary/higher education	0.177	0.382	0	1	0.204	0.403	0	1
Own any land	0.956	0.205	0	1	0.971	0.167	0	1
Hectares land owned/cultivated	0.768	0.741	0	10	0.709	0.793	0	17
Land size very small (0-0.2 ha)	0.120	0.325	0	1	0.125	0.331	0	1
Land size small (0.2-1 ha)	0.611	0.488	0	1	0.651	0.477	0	1
Land size medium (1-2 ha)	0.191	0.393	0	1	0.175	0.380	0	1
Land size large (>2 ha)	0.059	0.236	0	1	0.035	0.184	0	1
Own any livestock	0.956	0.205	0	1	0.966	0.183	0	1
Number of livestocks owned	12.145	10.132	0	83	12.377	9.833	0	89
Number of big livestocks owned	7.046	5.691	0	42	6.905	5.662	0	52
Hindu	0.800	0.400	0	1	0.808	0.394	0	1
Buddhist	0.141	0.348	0	1	0.113	0.317	0	1
Paved Road less than 1 hour away from HH	0.132	0.339	0	1	0.190	0.392	0	1
Paved Road 1-2 hours away from HH	0.111	0.314	0	1	0.163	0.369	0	1
Paved Road 2-4 hours away from HH	0.160	0.367	0	1	0.246	0.431	0	1
Paved Road 4-12 hours away from HH	0.259	0.438	0	1	0.194	0.395	0	1
Paved Road more than 12 hours away from HH	0.338	0.473	0	1	0.208	0.406	0	1
% of high caste hh in ward above 50%	0.505	0.500	0	1	0.460	0.499	0	1
Distance of ward to forest(hours)	1.347	1.139	0	5	1.168	1.179	0	10
Area Under Forest Decreased past 5 years	0.265	0.442	0	1	0.358	0.480	0	1
Time Taken to collect avg Bhari increased past 5 years	0.380	0.486	0	1	0.504	0.500	0	1
Trees planted privately past 5 years	0.234	0.424	0	1	0.092	0.289	0	1
Trees planted by community past 5 years	0.498	0.500	0	1	0.253	0.435	0	1
Trees planted by government past 5 years	0.063	0.243	0	1	0.036	0.187	0	1
Any user group in ward	0.669	0.471	0	1	1.000	0.000	1	1
Any development project in ward	0.720	0.449	0	1	0.955	0.207	0	1
Any natural disaster past 5 years	0.513	0.500	0	1	0.348	0.476	0	1
Ward population	789.278	746.009	104	4817	786.256	595.535	0	5000
Observations	1361				1891			

Notes: Author's computations using 2004 and 2011 NLSS surveys; the sample excludes Tarai belt and includes only villages with at least one FUG that have been sampled in the NLSS surveys; it includes only households which use and collect firewood.

Table 2.4: Determinants of village average female participation in ECs of FUGs

	(1)	(2)	(3)	(4)
Nlss 2011	0.008	-0.056***	-0.040	-0.043
	(0.010)	(0.006)	(0.032)	(0.033)
HH head female			-0.004	-0.002
			(0.005)	(0.005)
HH head age			0.000	0.000
			(0.000)	(0.000)
HH size			0.002	0.002**
			(0.001)	(0.001)
HH head migrated			0.002	0.004
			(0.005)	(0.004)
HH head completed primary education			0.000	-0.001
			(0.004)	(0.003)
HH head completed secondary/higher education			-0.007*	-0.005
			(0.004)	(0.003)
Electric light source			-0.003	-0.003
			(0.013)	(0.011)
Number of livestocks owned			-0.000	-0.000*
			(0.000)	(0.000)
Hectares land owned/cultivated			-0.004	-0.005**
			(0.003)	(0.003)
Collect firewood in community forest			-0.003	-0.001
			(0.007)	(0.007)
Collect firewood in government forest			-0.016***	-0.016**
			(0.006)	(0.006)
Paved Road less than 1 hour away from HH			-0.019	-0.025
			(0.023)	(0.022)
Paved Road 1-2 hours away from HH			-0.032	-0.041**
			(0.023)	(0.020)
Paved Road 2-4 hours away from HH			-0.026	-0.030
			(0.020)	(0.019)
Paved Road 4-12 hours away from HH			-0.004	-0.003
			(0.016)	(0.015)
Distance of ward to forest(hours)			0.017***	0.016***
			(0.006)	(0.005)
Area Under Forest Decreased past 5 years			0.005	-0.009
			(0.013)	(0.013)
Time Taken to collect avg Bhari increased past 5 years			-0.019	-0.007
			(0.012)	(0.013)
% of high caste hh in ward above 50%			0.006	0.009
			(0.015)	(0.016)
Any user group in ward			-0.023	-0.035*
			(0.021)	(0.019)
Any development project in ward			0.009	0.013
			(0.018)	(0.019)
Any natural disaster past 5 years			0.008	0.008
			(0.013)	(0.013)
Number of FUGs in village			0.003**	0.001
			(0.001)	(0.001)
Village average FUGs area			-0.000	-0.000**
			(0.000)	(0.000)
Village average FUGs number of households			-0.000**	-0.000**
			(0.000)	(0.000)
District FE	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes
Obs.	3205	3205	3205	3205
R-squared	0.404	0.490	0.550	0.616

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: village average percentage of women in ECs. All columns show estimates with robust standard errors in parenthesis clustered at the village level. Reference categories: HH head with no education; paved road more than 12 hours away from HH; collect firewood in own land.* p<0.10, ** p<0.05, *** p<0.01.

Table 2.5: Determinants of quantity of firewood collected and female participation

	(1)	(2)	(3)	(4)	(5)
Village average % of women in ECs of FUGs	-16.523	-28.189	-16.489	-19.454	-8.870
	(15.648)	(18.940)	(17.349)	(17.112)	(16.367)
Nlss 2011		-5.616	-74.274***	-73.993***	-82.099***
		(3.622)	(6.077)	(5.866)	(9.871)
HH size					5.798***
					(0.493)
HH head migrated					-2.297
					(2.261)
HH head completed primary education					-4.594*
					(2.394)
HH head completed secondary/higher education					-1.974
					(2.391)
Electric light source					10.602***
					(3.417)
Number of livestocks owned					0.632***
					(0.133)
Hectares land owned/cultivated					2.638*
					(1.389)
Paved Road less than 1 hour away from HH					-1.511
					(6.720)
Paved Road 1-2 hours away from HH					1.504
					(6.468)
Paved Road 2-4 hours away from HH					2.966
					(5.698)
Paved Road 4-12 hours away from HH					2.051
					(4.649)
Distance of ward to forest(hours)					-3.687***
					(1.420)
Area Under Forest Decreased past 5 years					4.197
					(4.179)
Time Taken to collect avg Bhari increased past 5 years					-4.474
					(4.094)
% of high caste hh in ward above 50%					-9.780***
					(3.166)
Any user group in ward					-2.664
					(5.926)
Any development project in ward					-4.231
					(5.911)
Any natural disaster past 5 years					-3.272
					(3.071)
Number of FUGs in village					0.821*
					(0.425)
Village average FUGs area					0.034***
					(0.012)
Village average FUGs number of households					-0.008
					(0.019)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Obs.	3205	3205	3205	3205	3205
R-squared	0.001	0.090	0.166	0.184	0.274

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). All columns show estimates with robust standard errors in parenthesis clustered at the village level. Reference categories: HH head with no education; paved road more than 12 hours away from HH. * p<0.10, ** p<0.05, *** p<0.01.

Table 2.6: Summary statistics for village and household characteristics in pre-treament year for control and treatment groups

	Control	Treatment	Difference
HH size	5.119	5.243	-0.124
HH head migrated	0.313	0.289	0.024
HH head any completed education	0.640	0.769	-0.129***
HH head completed primary education	0.173	0.139	0.034
HH head completed secondary/higher education	0.188	0.092	0.095***
Electric light source	0.215	0.156	0.059**
Hectares land owned/cultivated	0.774	0.831	-0.058
Number of livestocks owned	11.603	17.029	-5.426***
Paved Road less than 1 hour away from HH	0.133	0.058	0.075***
Paved Road 1-2 hours away from HH	0.112	0.081	0.031
Paved Road 2-4 hours away from HH	0.155	0.214	-0.059*
Paved Road 4-12 hours away from HH	0.209	0.439	-0.231***
Paved Road more than 12 hours away from HH	0.391	0.208	0.183***
Distance of ward to forest(hours)	1.332	1.450	-0.118
Area Under Forest Decreased past 5 years	0.281	0.347	-0.066*
Time Taken to collect avg Bhari increased past 5 years	0.427	0.208	0.219***
% of high caste hh in ward above 50%	0.536	0.341	0.195***
Any user group in ward	0.661	0.653	0.008
Any development project in ward	0.741	0.520	0.221***
Any natural disaster past 5 years	0.510	0.653	-0.143***
Number of FUGs in village	7.690	8.775	-1.084***
Village average FUGs area	96.425	97.939	-1.515
Village average FUGs number of households	131.222	104.636	26.586***
Observations	1188	173	

Notes: Author's computations using 2004 NLSS survey and FUG Database. The pre-treatment year is 2004. * p<0.10, ** p<0.05, *** p<0.01.

Table 2.7: Determinants of quantity of firewood collected and female participation: difference-in-difference estimates

	(1)	(2)	(3)	(4)	(5)
After 2009*Nlss 2011	-20.965*	-17.843*	-25.282*	-25.692**	-21.354**
	(12.689)	(10.660)	(13.723)	(12.044)	(10.790)
Nlss 2011	-2.532	-3.536	-73.348***	-74.173***	-83.653***
	(4.007)	(3.778)	(6.098)	(5.478)	(9.970)
After 2009	6.368	13.763	23.087*	16.796	12.212
	(11.253)	(11.132)	(12.156)	(14.108)	(12.915)
HH size					5.855***
					(0.485)
HH head migrated					-2.365
					(2.195)
HH head completed primary education					-4.237*
					(2.382)
HH head completed secondary/higher education					-1.490
					(2.424)
Electric light source					10.265***
					(3.420)
Hectares land owned/cultivated					2.490*
					(1.399)
Number of livestocks owned					0.620***
					(0.132)
Paved Road less than 1 hour away from HH					-0.154
					(6.580)
Paved Road 1-2 hours away from HH					2.205
					(6.263)
Paved Road 2-4 hours away from HH					3.272
					(5.551)
Paved Road 4-12 hours away from HH					1.148
					(4.672)
Distance of ward to forest(hours)					-3.765***
					(1.335)
Area Under Forest Decreased past 5 years					4.659
					(4.142)
Time Taken to collect avg Bhari increased past 5 years					-3.803
					(4.040)
% of high caste hh in ward above 50%					-9.995***
					(3.184)
Any user group in ward					-1.771
					(5.468)
Any development project in ward					-4.425
					(5.308)
Any natural disaster past 5 years					-4.356
					(2.951)
Number of FUGs in village					0.872**
					(0.422)
Village average FUGs area					0.037***
					(0.011)
Village average FUGs number of households					-0.013
					(0.017)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Obs.	3252	3252	3252	3252	3252
R-squared	0.009	0.091	0.169	0.185	0.275

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). All columns show estimates with robust standard errors in parenthesis clustered at the village level. Reference categories: HH head with no education; paved road more than 12 hours away from HH. * p<0.10, ** p<0.05, *** p<0.01.

Table 2.8: Placebo regressions for determinants of quantity of firewood collected (1)

	(1)	(2)	(3)	(4)	(5)
Panel A					
After 2007*Nlss 2011	4.595	2.604	2.028	0.415	8.405
	(9.013)	(9.233)	(9.286)	(9.175)	(10.452)
Nlss 2011	-3.537	-3.905	-73.348***	-71.464***	-81.471***
	(4.580)	(4.234)	(6.115)	(6.255)	(9.259)
After 2007	-5.873	-0.768	0.230	-20.689	-17.278
	(5.862)	(7.790)	(6.852)	(13.785)	(16.916)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2720	2720	2720	2720	2720
R-squared	0.001	0.080	0.165	0.177	0.274
Panel B					
After 2006*Nlss 2011	-5.153	-3.517	10.674	11.615	17.533*
	(9.384)	(9.982)	(9.335)	(9.637)	(9.558)
Nlss 2011	-2.974	-3.886	-73.348***	-71.357***	-82.413***
	(4.830)	(4.491)	(6.121)	(6.870)	(9.807)
After 2006	-0.320	-2.560	-7.915	-19.908	-21.008
	(6.037)	(8.459)	(5.925)	(12.238)	(14.550)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2511	2511	2511	2511	2511
R-squared	0.002	0.086	0.173	0.186	0.284
Panel C					
After 2005*Nlss 2011	5.162	15.977	16.080	17.163	7.409
	(11.356)	(13.423)	(10.494)	(11.087)	(10.000)
Nlss 2011	-3.938	-5.804	-73.348***	-67.361***	-70.965***
	(4.988)	(4.554)	(6.133)	(7.909)	(10.265)
After 2005	-8.914	-11.373	-7.008	-11.495	3.917
	(7.385)	(10.161)	(5.985)	(14.415)	(14.563)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2263	2263	2263	2263	2263
R-squared	0.002	0.101	0.180	0.198	0.300
Panel D					
After 2004*Nlss 2011	20.439	28.251	23.289	32.469*	21.563
	(15.166)	(19.292)	(14.210)	(16.740)	(15.679)
Nlss 2011	-5.165	-7.365	-73.348***	-69.360***	-74.127***
	(4.994)	(4.520)	(6.143)	(7.710)	(9.646)
After 2004	-10.779	-14.058	-5.621	-35.776	58.139
	(7.436)	(12.198)	(5.922)	(22.162)	(37.479)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2076	2076	2076	2076	2076
R-squared	0.004	0.119	0.198	0.214	0.316

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). Results are obtained using difference-in-difference estimation strategy. All columns show estimates with robust standard errors in parenthesis clustered at the village level. * p<0.10, ** p<0.05, *** p<0.01.

Table 2.9: Placebo regressions for determinants of quantity of firewood collected (2)

	(1)	(2)	(3)	(4)	(5)
After 2009*Nlss 2004	6.488	6.057	5.879	13.283	17.549
	(16.813)	(15.111)	(15.247)	(16.561)	(14.002)
Nlss 2004	-15.511***	-17.480***	-16.940	-17.682	-22.549
	(5.041)	(3.902)	(20.302)	(20.804)	(17.982)
After 2009	-0.120	11.223	17.208*	12.108	-8.178
	(12.486)	(11.465)	(9.135)	(12.408)	(10.485)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2004	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2643	2643	2643	2643	2580
R-squared	0.016	0.202	0.305	0.319	0.432

Notes: Author's computations using 1996, 2004 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). Results are obtained using difference-in-difference estimation strategy. All columns show estimates with robust standard errors in parenthesis clustered at the village level. * p<0.10, ** p<0.05, *** p<0.01.

2.A Appendix

Figure 2.A.1: Percentage of women in ECs of FUGs by year of FUGs formation

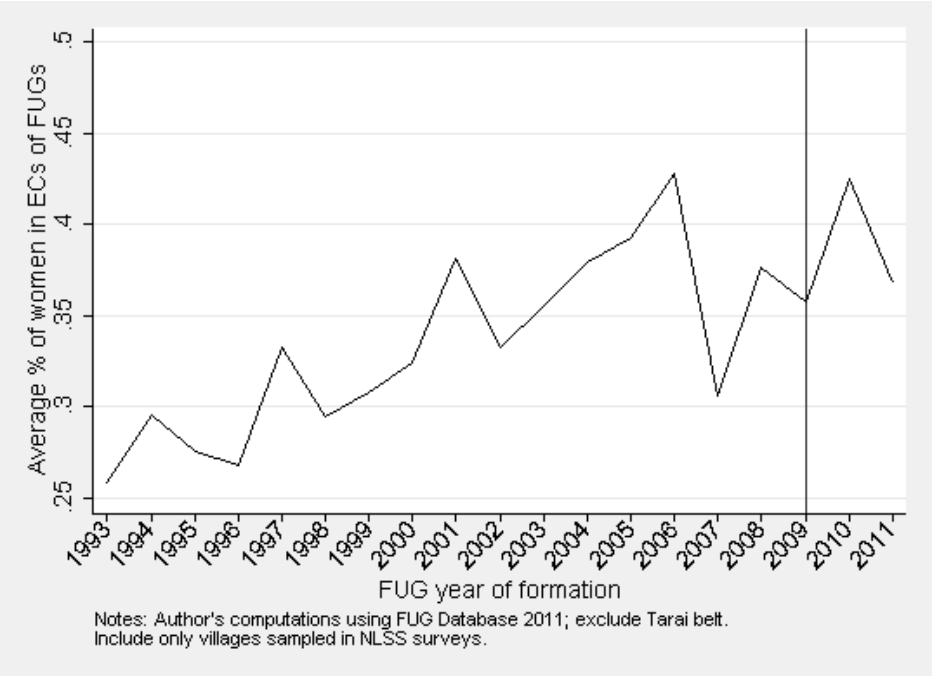


Figure 2.A.2: Number of new FUGs by year of FUGs formation

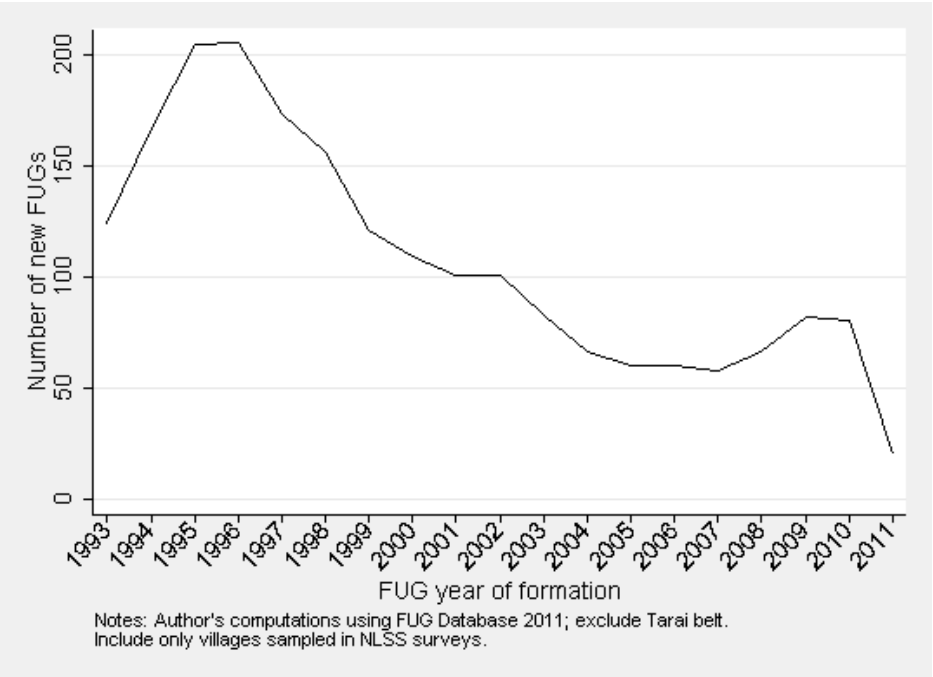


Figure 2.A.3: Total new area of forest handed over by year of FUGs formation

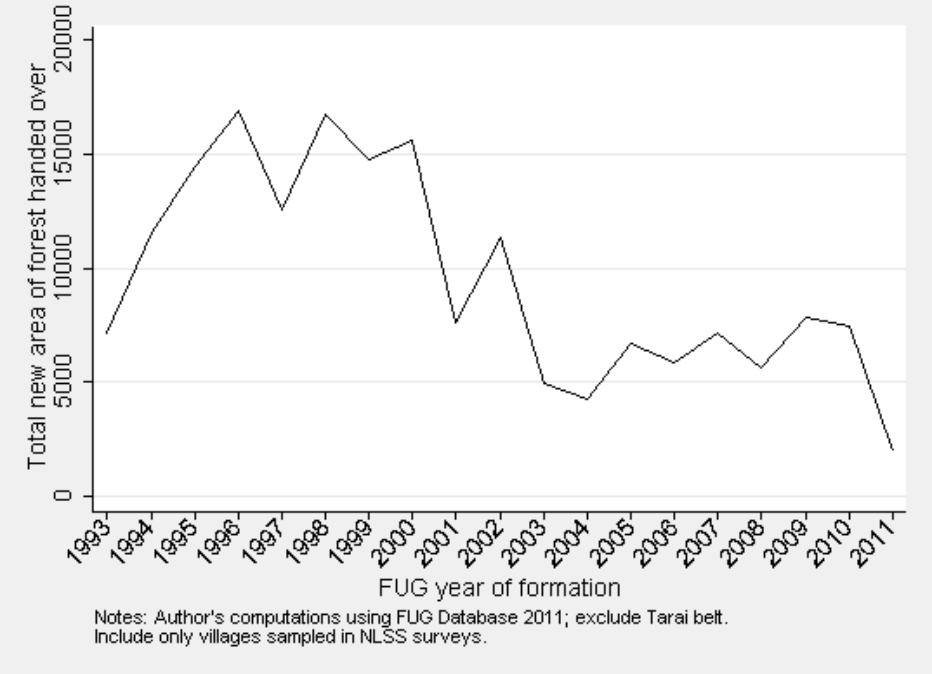


Figure 2.A.4: Total new number of households in FUGs by year of FUGs formation

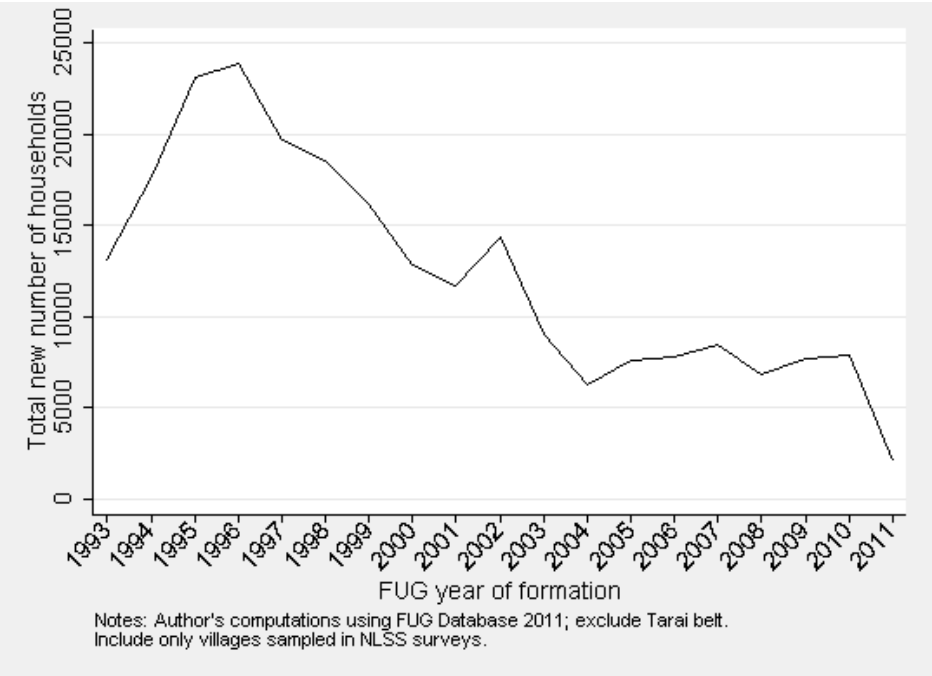


Table 2.A.1: FUG characteristics on observations with missing information on women in ECs - Census data

	Obs.	Mean	St.Dev.	Min	Max
Eastern region	1577	0.098	0.297	0	1
Central region	1577	0.201	0.401	0	1
Western region	1577	0.238	0.426	0	1
Mid Western region	1577	0.188	0.391	0	1
Far Western region	1577	0.275	0.447	0	1
Mountains	1577	0.101	0.301	0	1
Hills	1577	0.741	0.438	0	1
Tarai	1577	0.159	0.365	0	1
Forest handed over (Ha)	1573	77.868	137.852	0	2591
Number of households in the group	1570	130.662	198.497	0	4334
Number of EC members	1073	11.027	2.949	0	27

Notes: Author's computations using FUG Database. Include only observations with missing information on percentage of women in ECs.

Table 2.A.2: Test on whether the percentage of women is significantly above trend (1)

	(1)	(2)
Trend	0.008***	0.007***
	(0.000)	(0.000)
FUG formed after 2009		0.035***
		(0.009)
Obs.	13814	13814
R-squared	0.034	0.035

Notes: Author's computations using FUG Database.
* p<0.10, ** p<0.05, *** p<0.01

Table 2.A.3: Test on whether the percentage of women is significantly above trend (2)

	(1)	(2)	(3)	(4)
Year of formation=1993	-0.110***	-0.128***	-0.095***	-0.117***
	(0.010)	(0.011)	(0.012)	(0.015)
Year of formation=1994	-0.067***	-0.085***	-0.052***	-0.074***
	(0.010)	(0.011)	(0.012)	(0.015)
Year of formation=1995	-0.080***	-0.098***	-0.065***	-0.087***
	(0.009)	(0.011)	(0.012)	(0.014)
Year of formation=1996	-0.068***	-0.086***	-0.053***	-0.076***
	(0.010)	(0.011)	(0.012)	(0.014)
Year of formation=1997	-0.062***	-0.080***	-0.047***	-0.069***
	(0.010)	(0.011)	(0.012)	(0.015)
Year of formation=1998	-0.044***	-0.062***	-0.029**	-0.052***
	(0.010)	(0.012)	(0.013)	(0.015)
Year of formation=1999	-0.042***	-0.059***	-0.027**	-0.049***
	(0.011)	(0.012)	(0.013)	(0.015)
Year of formation=2000	-0.039***	-0.057***	-0.024*	-0.046***
	(0.011)	(0.012)	(0.013)	(0.015)
Year of formation=2001	0.006	-0.012	0.021	-0.001
	(0.012)	(0.013)	(0.014)	(0.016)
Year of formation=2002	0.006	-0.012	0.021	-0.001
	(0.013)	(0.014)	(0.015)	(0.017)
Year of formation=2003	0.000	-0.018	0.015	-0.007
	(0.013)	(0.014)	(0.015)	(0.017)
Year of formation=2004	0.007	-0.011	0.022	-0.000
	(0.013)	(0.014)	(0.015)	(0.017)
Year of formation=2005	0.012	-0.006	0.027	0.004
	(0.015)	(0.016)	(0.017)	(0.018)
Year of formation=2006	0.007	-0.011	0.022	
	(0.015)	(0.016)	(0.017)	
Year of formation=2007	-0.015	-0.033**		-0.022
	(0.013)	(0.014)		(0.017)
Year of formation=2008	0.018		0.033**	0.011
	(0.012)		(0.014)	(0.016)
Year of formation=2010	0.079***	0.061***	0.094***	0.072***
	(0.012)	(0.013)	(0.014)	(0.016)
Year of formation=2011	0.059***	0.041**	0.074***	0.052***
	(0.017)	(0.017)	(0.018)	(0.020)
Year of formation=2009		-0.018	0.015	-0.007
		(0.012)	(0.013)	(0.015)
Obs.	13814	13814	13814	13814
R-squared	0.040	0.040	0.040	0.040

Notes: Author's computations using FUG Database; Reference categories: in column 1 is year formation=2009, in column 2 is year of formation=2008, in column 3 is year formation=2007, in column 4 is year formation=2006; p<0.10, ** p<0.05, *** p<0.01.

Table 2.A.4: FUG characteristics by FUGs year of formation - Census data

FUG year of formation	Number new FUGs	Total N FUGs	Total new area handed over	Total new N of HH	Average % of women in ECs	Mountains	Hills	Eastern	Central	Western	Mid Western	Far Western
1993	786	786	64980	87884	.25	.22	.78	.28	.17	.31	.09	.16
1994	1214	2000	93784	131714	.29	.15	.85	.22	.17	.33	.11	.17
1995	1601	3601	126739	180093	.28	.17	.83	.24	.2	.28	.14	.14
1996	1591	5192	132882	172212	.29	.18	.82	.2	.22	.25	.2	.13
1997	1426	6618	117458	150846	.3	.18	.82	.19	.21	.27	.19	.14
1998	1240	7858	114409	137021	.32	.2	.8	.15	.2	.29	.2	.16
1999	1024	8882	83716	112777	.32	.18	.82	.13	.24	.3	.21	.12
2000	934	9816	84823	101663	.32	.16	.84	.17	.21	.27	.2	.16
2001	821	10637	78692	83484	.37	.19	.81	.08	.39	.24	.16	.13
2002	537	11174	44996	60426	.37	.16	.84	.12	.48	.28	.08	.05
2003	502	11676	33909	53883	.36	.2	.8	.14	.25	.36	.14	.11
2004	522	12198	39149	52283	.37	.11	.89	.18	.29	.35	.1	.08
2005	365	12563	32731	39190	.37	.11	.89	.16	.35	.33	.09	.07
2006	286	12849	25362	31304	.37	.12	.88	.24	.24	.39	.11	.02
2007	385	13234	45624	47218	.35	.08	.92	.19	.25	.26	.28	.02
2008	461	13695	39915	49142	.38	.05	.95	.19	.12	.29	.38	.02
2009	594	14289	55051	61524	.36	.07	.93	.14	.26	.21	.33	.05
2010	559	14848	57862	54734	.44	.05	.95	.08	.25	.21	.45	.02
2011	181	15029	16742	18032	.42	.07	.93	.1	.08	.35	.46	0

Notes: Author's computations using FUG Database. Exclude Tarai belt.

Table 2.A.5: FUG characteristics - Census data (include only villages sampled in NLSS surveys)

	count	mean	sd	min	max
Eastern region	2047	0.166	0.372	0	1
Central region	2047	0.282	0.450	0	1
Western region	2047	0.271	0.444	0	1
Mid Western region	2047	0.189	0.392	0	1
Far Western region	2047	0.093	0.290	0	1
Mountains	2047	0.154	0.361	0	1
Hills	2047	0.846	0.361	0	1
Forest handed over (Ha)	2045	88.439	167.604	0	4500
Number of households in the group	2046	115.600	91.357	0	1209
Number of EC members	2006	11.621	2.601	0	25
% of women in EC	1905	0.326	0.213	0	1

Notes: Author's computations using FUG Database. Exclude Tarai belt. Include only villages sampled in NLSS surveys.

Table 2.A.6: Average percentage of women in ECs of FUGs - Census data (include only villages sampled in NLSS surveys)

	All	1993-2000	2001-2006	2007-2009	2010-2011
% women in ECs=0	0.024	0.032	0.009	0.020	0.010
% women in ECs between 0-25%	0.376	0.468	0.257	0.239	0.163
% women in ECs between 25-33%	0.205	0.187	0.226	0.269	0.184
% women in ECs between 33-50%	0.277	0.221	0.357	0.343	0.429
% women in ECs between 50-99%	0.062	0.049	0.068	0.080	0.143
% women in ECs=100%	0.056	0.044	0.083	0.050	0.071
Observations	1905	1140	456	201	98

Notes: Author's computations using FUG Database. Exclude Tarai belt. Include only villages sampled in NLSS surveys

Table 2.A.7: Comparison of average household and village characteristics between villages with and without FUGs

	2004			2011		
	With FUGs	Without FUGs	Diff.	With FUGs	Without FUGs	Diff.
Eastern	0.207	0.200	0.007	0.214	0.111	0.103**
Central	0.306	0.200	0.106	0.260	0.556	-0.295***
Western	0.240	0.400	-0.160*	0.214	0.222	-0.008
Mid-west	0.165	0.200	-0.035	0.185	0.111	0.074*
Far-west	0.083	0.000	0.083***	0.127	0.000	0.127***
hills	0.760	0.600	0.160*	0.844	0.889	-0.045
Quantity firewood collected (Bhari/year)	90.996	95.750	-4.754	84.884	104.263	-19.379*
Time to collect firewood (Hours/bhari)	3.526	4.104	-0.578*	3.889	4.501	-0.612
Use firewood past 12 months	0.974	0.817	0.157**	0.965	0.611	0.354***
Collect firewood past 12 months	0.963	0.980	-0.017	0.954	0.879	0.075
Collect firewood in own land	0.263	0.208	0.055	0.250	0.362	-0.112
Collect firewood in community forest	0.337	0.167	0.170**	0.475	0.293	0.182**
Collect firewood in government forest	0.357	0.583	-0.226**	0.235	0.310	-0.075
Collect firewood in other forest	0.043	0.042	0.002	0.040	0.034	0.005
Electric light source	0.242	0.383	-0.142*	0.496	0.713	-0.217***
Gas,Oil,Kerosene light source	0.652	0.383	0.269***	0.297	0.148	0.149***
Use firewood as cooking fuel	0.944	0.817	0.128*	0.921	0.556	0.365***
Use dung/leaves as cooking fuel	0.008	0.000	0.008***	0.006	0.028	-0.022
Gas,Oil,Kerosene as cooking fuel	0.048	0.183	-0.136**	0.074	0.417	-0.343***
HH size	5.046	4.367	0.679**	4.761	4.111	0.650**
HH head female	0.223	0.250	-0.027	0.281	0.167	0.114**
HH head married	0.824	0.783	0.041	0.857	0.815	0.043
HH head age	46.663	43.367	3.296	46.824	48.370	-1.546
HH head migrated	0.318	0.500	-0.182**	0.289	0.343	-0.054
HH head any compl edu	0.647	0.717	-0.070	0.536	0.500	0.036
HH head completed primary education	0.164	0.133	0.031	0.233	0.148	0.085*
HH head completed secondary/higher education	0.189	0.150	0.039	0.231	0.352	-0.121*
Own any land	0.941	0.833	0.107*	0.948	0.722	0.226***
Hectares land owned/cultivated	0.757	0.736	0.021	0.698	0.376	0.322***
Land size very small (0-0.2 ha)	0.118	0.267	-0.148*	0.126	0.287	-0.161***
Land size small (0.2-1 ha)	0.602	0.383	0.219**	0.630	0.352	0.278***
Land size medium (1-2 ha)	0.186	0.100	0.086*	0.171	0.111	0.059
Land size large (¿2 ha)	0.059	0.100	-0.041	2076	0.009	0.028**
Own any livestock	0.935	0.767	0.168**	0.928	0.593	0.336***
Number of livestocks owned	11.870	12.467	-0.597	11.789	5.694	6.095***
Number of big livestocks owned	6.824	5.783	1.040	6.568	2.750	3.818***
Hindu	0.802	0.450	0.352***	0.810	0.750	0.060
Buddhist	0.141	0.450	-0.309***	0.109	0.194	-0.085*
Paved Road less than 1 hour away from HH	0.145	0.300	-0.155*	0.223	0.454	-0.231***
Paved Road 1-2 hours away from HH	0.110	0.067	0.043	0.150	0.102	0.048
Paved Road 2-4 hours away from HH	0.160	0.033	0.127***	0.234	0.111	0.123***
Paved Road 4-12 hours away from HH	0.233	0.000	0.233***	0.188	0.111	0.077*
Paved Road more than 12 hours away from HH	0.351	0.600	-0.249***	0.205	0.222	-0.018
% of high caste hh in ward above 50%	0.521	0.400	0.121	0.474	0.778	-0.304***
Distance of ward to forest(hours)	1.337	1.350	-0.013	1.192	1.056	0.136
Area Under Forest Decreased past 5 years	0.281	0.200	0.081	0.364	0.111	0.253***
Time Taken to collect avg Bhari increased past 5 years	0.397	0.800	-0.403***	0.526	0.444	0.082
Trees planted privately past 5 years	0.231	0.200	0.031	0.092	0.222	-0.130**
Trees planted by community past 5 years	0.496	0.400	0.096	0.266	0.111	0.155***
Trees planted by government past 5 years	0.074	0.000	0.074***	0.040	0.222	-0.182***
Any user group in ward	0.669	0.400	0.269***	1.000	1.000	0.000
Any development project in ward	0.719	0.800	-0.081	0.954	1.000	-0.046***
Any natural disaster past 5 years	0.529	0.400	0.129	0.341	0.222	0.119**
ward population	794.709	760.000	34.709	895.890	1058.667	-162.776
Observations	1452	60		2076	108	

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database.* p<0.10, ** p<0.05, *** p<0.01.

Table 2.A.8: Determinants of quantity of firewood collected on a sample that includes outliers

	(1)	(2)	(3)	(4)	(5)
After 2009*Nlss 2011	-23.634*	-20.774*	-25.282*	-25.462**	-22.185**
	(12.725)	(10.690)	(13.722)	(12.226)	(10.752)
Nlss 2011	0.137	-0.697	-73.348***	-74.931***	-82.032***
	(4.121)	(3.864)	(6.098)	(5.037)	(11.010)
After 2009	6.368	15.410	23.087*	16.214	10.044
	(11.253)	(11.131)	(12.156)	(14.236)	(13.000)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	3256	3256	3256	3256	3256
R-squared	0.007	0.068	0.128	0.138	0.204

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). Results are obtained using difference-in-difference estimation strategy. All columns show estimates with robust standard errors in parenthesis clustered at the village level. Sample includes 4 outlier observations on dependent variable in 2011 NLSS survey.* p<0.10, ** p<0.05, *** p<0.01.

Chapter 3

Short- and long-term impact of violence on education: the case of Timor Leste

3.1 Introduction

The developmental consequences of violence and conflict are far reaching, affecting millions of men, women, and children (World Bank, 2011). The objective of this essay is to examine one important channel linking violent conflict and development outcomes: the education of children living in contexts of conflict and violence. The chapter focuses on the case of Timor Leste, particularly the last wave of violence in 1999 during the withdrawal of Indonesian troops from the territory. We analyse the short-term impact of the 1999 violence on primary school attendance in 2001 and its longer-term impact on primary school completion in 2007. In addition, we separately examine the impact of early periods of high-intensity violence (HVI) during the 25 years of Indonesian occupation and the effects of the entire conflict on primary school completion in 2007 to compare the average impact of the overall conflict period with the educational impact of singular peaks of violence.

This is a unique and important feature of this essay because long conflicts are not characterised by constant levels of violence. Although armed conflict has considerable effects on people's lives, there is an important theoretical distinction between the conflict process and the violence that occurs at different times and in different places (Kalyvas, 2006). From a theoretical perspective, the long-term developmental effects of violent conflict are ambiguous. Standard neoclassical growth models predict that the temporary destruction of capital can be overcome in the long run by higher investments in affected areas.[1] However, the long-term destructive effects of violent conflict may remain entrenched in certain regions and among some population groups even if economic growth converges at the aggregate level. Recent research on the microlevel effects of violent conflict has shown that the negative impact of conflict on educational outcomes, labor market participation, and the health status of individuals and households may be observed decades after the conflict.[2] Children may be particularly affected by conflict because many human capital investments are age specific. The destruction of human capital during childhood is a well-documented mechanism explaining long-term trends in household welfare (Alderman et al., 2006; Case and Paxson, 2008; Maccini and Yang, 2009). The educational effects of violent conflict are particularly substantial. The existing literature shows that violent conflict almost always results in reductions in educational access and attainment (Akresh and de Walque, 2011; Alderman et al., 2006; Chamarbagwala and Morán, 2011; Shemyakina, 2011). Relatively minor shocks to educational access during childhood can lead to significant and long-lasting detrimental effects on individual human capital accumulation (Akbulut-Yuksel, 2009; Ichino and Winter-Ebmer, 2004; Leòn, 2012). We analyse the short- and long-term impacts of violence on primary school attendance and completion in Timor Leste using data from two nationally representative household surveys collected

[1] See the discussion in Blattman and Miguel (2010) and the evidence in Bellows and Miguel (2006), Davis and Weinstein (2002) and Miguel and Roland (2011).

[2] See reviews in Blattman and Miguel (2010) and Justino (2009, 2012b).

in 2001 and in 2007. We focus on primary school outcomes because most individuals in Timor Leste (approximately 65 percent) have, at most, only primary school education (TLSS, 2007a). Our identification strategy exploits both individual-level violence measures and temporal and geographical variation in the incidence of the conflict using data from the East Timor Human Rights Violations Database (CAVR, 2006). Our results show mixed evidence for the impact of violent conflict on educational outcomes. Mirroring the findings of Bellows and Miguel (2006) and others, we find evidence for a rapid recovery in educational outcomes among girls in Timor Leste. However, we find that the 1999 wave of violence in Timor Leste, as well as the peaks of violence in the 1970s and 1980s, resulted in persistent negative effects on primary school attendance and completion among boys. We present evidence suggesting that boys were less able to benefit from post-conflict recovery as a result of household trade-offs between education and economic survival that may have led to the removal of boys from school. The chapter is structured as follows. Section 3.2 provides a descriptive background of the conflict in Timor Leste and the country's education sector. In section 3.3, we describe the datasets, discuss our identification strategy, and present some descriptive results. Section 3.4 discusses our empirical results as well as a range of robustness checks. Section 3.5 concludes the chapter.

3.2 Violent conflict and the education sector in Timor Leste

Timor Leste was under Portuguese colonial rule from 1500 to 1974. After the Portuguese left, Indonesia forcefully annexed the territory, leading to a guerrilla war spurred by the Revolutionary Front for an Independent East Timor and its armed wing (the Armed Forces for the National Liberation of East Timor). Several thousand individuals were forcibly displaced during the Indonesian occupation and forced to live in extreme conditions without adequate food, shelter, or health facilities (Felgueiras and Martins, 2006; Gusmão, 2004). Approximately 60,000 people lost their lives in the early years of the occupation. The

number of deaths reached 200,000 by the end of the occupation (UNDP, 2002). The situation in Timor Leste received little international attention until the Santa Cruz massacre in November 1991, in which Indonesian forces killed 200 protesters. The massacre was broadcast by the international media and raised considerable awareness of human rights violations during the Indonesian occupation. The independence movement received support from the Portuguese government and international organizations, including the UN. These events, in addition to the 1997 financial crisis, resulted in Indonesia agreeing to a referendum on the independence of Timor Leste. On August 30, 1999, 79 percent of the population of Timor Leste voted in favor of independence. The aftermath of the referendum generated a wave of destruction, violence, and human rights violations by Indonesian forces and militias (Alonso and Brugha, 2006). The number of killings during this wave of violence has been estimated at between 1,000 and 2,000 people, approximately 0.2 percent of the Timorese population (Robinson, 2003; UNDP, 2002). This wave of violence was characterised by massive displacement and the destruction of private dwellings and public infrastructure following the "scorched-earth" tactics employed by the Indonesian troops and pro-Indonesia militia groups (CAVR, 2006; UNDP, 2002). Approximately 80 percent of the country's infrastructure and buildings were destroyed during the withdrawal of Indonesian troops and militias (UNDP, 2002). In October 1999, a United Nations Transitional Administration was established in Timor Leste.

3.2.1 Variation in the conflict across time and space

The conflict in Timor Leste has evolved in different ways over time and across space. The Timor Leste Commission for Reception, Truth, and Reconciliation, established in 2001, has identified three distinct phases of the conflict during the period between December 1975 and September 1999 (CAVR, 2005). The first phase, from 1975 to 1984, was related to the initial Indonesian invasion and occupation of Timor Leste. The first few years,

from 1975 to 1979, were the most intense in terms of killings and destruction. The second phase, from 1985 to 1998, was characterised by the consolidation and normalisation of the occupation. Although people were killed in this phase (for instance, during the Santa Cruz massacre), the violence during this period was of relatively low intensity. The third phase of the conflict was identified with the 1999 withdrawal of Indonesian troops and the accompanying wave of violence. The main peaks of violence across these three periods were 1975-79, 1983, and 1999, coinciding with more intense fighting between the two factions (CAVR, 2005). There were two main types of victims during this last wave of violence. The first was urban households, some (but not all) of which were supporters of the independence movement among or related to the Timorese intelligentsia. Some of these individuals were targeted and killed, whereas others fled from their areas of residence, fearing attacks by the Indonesian troops and militias in Dili and other urban areas (CAVR, 2006; Robinson, 2003). The second set of victims was mostly poor farmers who fled to safer areas or fell victim to the scorched-earth tactics employed by Indonesian forces withdrawing from Timor Leste (CAVR, 2006).

The conflict was also characterised by significant variation at the geographical level, which we exploit in our empirical analysis. The violence was primarily concentrated in specific areas, and its geographic variation generally followed the movement of the Indonesian military forces. The occupation was more intense initially in the western region of Timor Leste because of the proximity to the West Timor border. It then spread to the central and eastern regions. The last wave of violence in 1999 was particularly intense in the western region and the urban areas of the central regions (CAVR, 2005). The concentration of violence in 1999 in the western districts was also due to a long-established network of pro-Indonesian groups since before 1999. In contrast, the eastern and central regions were important areas for the resistance forces (Robinson, 2003). We will explore this variation in violence across time and space in the empirical analysis below.

The levels of violence experienced in Timor Leste declined considerably after independence. In 2006, Timor Leste faced renewed civil strife as a result of fighting between different factions of the independence movement (Muggah et al., 2010; Scambary, 2009). Although fighting and violence have become less pronounced, some areas of Timor Leste continue to face serious challenges in terms of insecurity, youth unemployment, and violence (Muggah et al., 2010). This essay specifically focuses on the effects of the 1999 wave of violence and the previous years of the Indonesian occupation, but we also discuss the potential implications of the 2006 civil strife on our results in section 3.4.4.

3.2.2 The education sector in Timor Leste

Beginning in 1999, substantial funds from bilateral and multilateral donors flowed into Timor Leste to support the reconstruction and rehabilitation of the country. Although Timor Leste was severely devastated during the 1999 wave of violence, the reconstruction of state institutions, school systems, infrastructure, and markets was relatively successful and rapid (World Bank, 2003b). The main development indicators for the country in 2001 were close to the pre-1999 values. However, Timor Leste was (and is) one of the world's least developed countries (UNDP, 2002). Under Portuguese colonial rule, the Catholic Church was the major provider of education, with schooling primarily available for the elite in urban areas. The literacy rate was approximately 5 percent in 1975, and gender disparities were large (UNDP, 2002). The Indonesian government expanded educational access to the entire population of Timor Leste, primarily as a means of controlling the population (Nicolai, 2004). Enrollment rates increased over those years, and gender gaps began to close (UNDP, 2002). Despite this progress, educational performance under the Indonesian occupation was characterised by delayed school entry, high repetition rates, and high dropout rates owing to the low quality of schools and teaching and high fees. Some Timorese were also unwilling to send their children to school because this was perceived

as a sign of participation in the repressive Indonesian system (UNDP, 2002). In 1995, less than half of individuals aged between 15 and 19 had completed primary school education (UNDP, 2002).

The school system was almost totally destroyed in the immediate aftermath of the 1999 violence, and schools did not reopen until October 2000. However, children were still able to attend classes taught in the open air in makeshift camps (Rohland and Cliffe, 2002), and substantial effort was applied to the reconstruction of the education system in Timor Leste (World Bank, 2003a). In particular, the Trust Fund for East Timor included substantial funding for the renovation of damaged schools and the construction of new ones (USD 27.8 million over three years). Within a few months, many schools had been rebuilt, thousands of books had been replaced, and teachers had been recruited (Rohland and Cliffe, 2002; World Bank, 2003a).

During this rapid reconstruction process, primary school enrollment rates improved significantly. This increase was aided by the elimination of school fees and the reintroduction of Portuguese as the primary language of instruction. As a result, a large number of over-age students enrolled in primary school for the first time, and net primary school enrollment in Timor Leste rose from 65 to 74 percent between 1999 and 2001. Gender differentials decreased significantly as a result of a large increase in female literacy rates (World Bank, 2003a). However, the reconstruction of the school system in Timor Leste faced numerous challenges owing to the shortage of teachers and schools (UNDP, 2006). Makeshift open-air schools were not ideal means of teaching children, and emergency funds were only available for a limited period of time. In 2007, most of the Timorese population continued to have little or no education.

3.3 Data description and identification strategy

Our empirical study is based on two cross-sectional household surveys: the Timor Leste Living Standard Measurement Surveys (TLSS), which were jointly conducted by the National Statistics Directorate in Timor Leste and the World Bank in 2001 and 2007, including a broad range of individual- and household-level indicators. The TLSS 2001 surveyed 1,800 households from 100 *sucos* (villages), covering nearly 1 percent of the population (TLSS, 2001). The survey included direct questions on the exposure of individuals and households to the violence in 1999. The TLSS 2007 covered a sample of 4,477 households from all 498 sucos in Timor Leste (TLSS, 2007b). The TLSS 2007 was conducted over a period of 12 months between December 2007 and January 2008.[3] The TLSS 2007 did not contain direct information on exposure to violence. To identify individuals and households affected by violence, we exploit data on the number of killings across time and space collected in the Human Rights Violations Database to identify districts and years that experienced HVI at the beginning of and during the occupation and following the withdrawal of Indonesian troops in 1999. These data were compiled by the Commission for Reception, Truth, and Reconciliation from voluntary statements made by people (victims, perpetrators, and others) affected by violence.

3.3.1 Identification strategy I: The impact of violence on school attendance in 2001

We first investigate the short-term impact of the 1999 violence on the school attendance of boys and girls observed in 2001.[4] We consider two different channels of exposure

[3]The survey was launched in March 2006 but had to be suspended due to the outbreak of internal violence in the country (mostly in Dili). The survey was resumed in January 2007 and conducted over one year. All households interviewed in 2006 (351 households) were revisited and reinterviewed in 2007. Those not found at the time of the new interview (34 households) were replaced with new households (TLSS, 2007b).

[4]We do not analyse primary school completion in 2001 because most children who were of school age in 1999 were still in school in 2001.

to violence. The first identifies individuals belonging to households that were displaced as a result of the 1999 wave of violence (all members displaced). The second identifies individuals in households that report having their homes completely destroyed by the violent attacks in 1999.[5]

The TLSS 2001 contains useful retrospective information on school attendance in three different school years: 1998/99, 1999/00, and 2000/01. We are interested in the year of recovery (2000/01). Because the 1999 violence primarily occurred in the summer and fall of 1999, we can assume with a high degree of confidence that the 1998/99 school year was not affected by conflict, whereas the 1999/00 school year began during the wave of violence. Note that many children continued to be able to attend school in 1999. However, these were generally makeshift open-air schools in internally displaced person camps established by the international community (Nicolai, 2004; Richter, 2009).

To employ the retrospective information on school attendance provided in the dataset, we exploit the time variation in school attendance status. We construct a panel dataset in which each individual is observed over three school years, and attendance status is time variant. We focus our analysis on individuals who were of primary school age over the 1998-2001 period, ensuring that all children had a minimum age of seven in 1998/99 and a maximum age of 12 in 2000/01.[6] We estimate the following equation using a linear probability model:

$$E_{it} = \alpha + \beta_1 T_2 + \beta_2 T_3 + \beta_3 V_i^k T_2 + \beta_4 V_i^k T_3 + \alpha_i + \epsilon_{it} \tag{3.1}$$

[5]The 2001 TLSS also contains self-reported information on the number of household members who have died as a result of violence. In our sample, 148 individuals (living in 27 households) reported the violent death of a household member. Of these individuals, 88 percent were also affected by displacement and/or dwelling destruction, and only 13 of those 148 individuals were children between the ages of 7 and 12 during the violence. We have re-estimated our model in table 3.5 excluding these 13 children. The results remain unchanged. These estimates are not reported but are available upon request.

[6]We have analysed a larger sample that includes children of primary school age in the year of the violence (i.e., between 7 and 12 years old in 1999). This includes individuals aged 6 in 1998 and aged 13 in 2000. The inclusion of these individuals may generate "spurious" results because they are not all of primary school age. We have estimated the model using both samples. The results (not shown) are very similar; therefore, we opted to concentrate on the most restrictive sample.

where E_{it} is a binary variable for school attendance for individual i at time t. T_2 and T_3 are year dummies for the 1999 violence and for the first year of the post-violence period (school year 2000/01), respectively. The reference year is the pre-violence year, 1998/99. The model includes individual fixed effects, α_i. ϵ_{it} is the random error term. We estimate robust standard errors to account for heteroscedasticity in the error term. In addition, as we expect observations within each village to be correlated, all standard errors are clustered at the village level.

Violence-affected individuals are identified using two different measures, V_i^k, with $k = 1, 2$ depending on whether displacement or the destruction of a home is included in the specification. Of the children in the sample, 16 percent and 25 percent live in households that were displaced or had their homes destroyed, respectively. We allow the violence measure to interact with both year dummies. The estimation of our specification employs a difference-in-difference methodology. The first difference compares the school attendance of individuals affected or not by the violence. The second difference compares the school attendance of children before and during the violence, and before and after the violence. Specifically, $V_i^k T_2$ represents the difference-in-difference term between the pre-war year and the year of conflict, whereas $V_i^k T_3$ represents the difference-in-difference term between the pre-war year and the post-war year. We focus our attention on the coefficient β_4 because we are primarily interested in understanding the effects of violence on post-war outcomes. We also explore both the separate and joint impacts of each channel of violence by adding a triple interaction between the two violence dummies and the time dummies. This specification allows us to isolate the impact of only being displaced, only having the home destroyed and being affected by both shocks. Of the children in our sample, 67.1 percent were not affected by any shock. Moreover, 7.5 percent of all children were only displaced, and 17.4 percent only had their homes destroyed. Finally, 8 percent of the sample was affected by both shocks. This specification ensures that the control group

does not include individuals affected by violence.

In table 3.1, we present average school attendance rates, disaggregated by gender and age groups, for the same cohort of children aged 7-10 years in 1998, 8-11 years in 1999, and 9-12 years in 2000. In general, the attendance rates for the whole sample increase over time and are higher for girls. The differences in means between boys and girls are statistically significant only for school attendance in the post-war year.

There are, however, considerable differences in attendance rates between children affected by violence and those who do not report victimization. These differences are reported in figure 3.1, where we disaggregate school attendance averages between violence-affected and unaffected individuals. As expected, we observe a decline in school attendance in 1999 for children affected by violence.

We present the individual and household characteristics of children affected by the 1999 violence in table 3.2. The table shows that children from displaced households are better off (i.e., higher education level of the parents, less farmers) overall than those from households that were not displaced. Many of these were urban households that fled their areas of residence because they feared being targeted by the Indonesian troops stationed in Dili and other urban areas in the central regions (CAVR, 2005; Robinson, 2003). Households that report having their homes destroyed by violent attacks or affected by both shocks are generally poor farmers living in rural areas. These households are likely to be indiscriminate victims of the scorched-earth tactics employed by the Indonesian troops withdrawing to West Timor (CAVR, 2005). Interestingly, we find that boys (aged 10-12) affected by displacement work more hours than unaffected individuals, whereas the opposite is true for girls.

We exploit the panel nature of the data to estimate the causal effects of the 1999 wave of violence on education outcomes. We estimated a fixed effects model,[7] which

[7]The fixed effects model is more appropriate than a random effects model because we would have to

allows us to eliminate time-invariant unobserved individual characteristics that may be correlated with the conflict measure and our dependent variable. As shown in equation (3.1), our specification also includes year dummies that allow us to control for unobserved time-variant heterogeneity.

To ensure that our key identifying assumption is not violated, we checked whether trends in education before the 1999 violence were parallel between groups affected by the violence and those unaffected by the violent events. We examined the average school grades of affected individuals and unaffected individuals who were not exposed to the 1999 violence during their primary school years and who were old enough in 1999 to have at least completed primary school.[8] The results indicate that it is unlikely that pre-existing differences in education trends drive our post-conflict outcomes (see figure 3.2). This evidence, combined with the association of the violence with the Indonesian troop movements described in section 3.2, strongly indicates that the effects of the violence that occurred in Timor Leste in 1999 on individual educational outcomes are unlikely to be driven by a systematic correlation between the determinants of individual educational attainment levels before 1999 and the incidence of the 1999 violence at the individual level.

Despite the evidence discussed above, there is a small possibility that this strategy may be unable to control for all of the unobservable individual characteristics that may be correlated with both conflict incidence and educational outcomes. In particular, there are two common omitted variables in empirical analyses of conflict that may affect our results (see Kalyvas (2006)). The first variable is a household's level of support for armed groups. Supporters of pro-independence groups in Timor Leste were likely to be targets of violent attacks by Indonesian forces. In that case, the correlation between the conflict variables

assume that the unobserved component of the individual fixed effects and the other covariates specified in the equation are uncorrelated. This assumption is likely to be violated in our case. This choice is also supported by Hausman test results.

[8] We do not include cohorts born after 1985 because the educational attainment of these individuals might be censored.

and this potentially omitted variable would be positive. If supporters were also more educated and hence more likely to send their children to school, our estimated effect would be biased upward. The use of a fixed effects model controls for these effects as a component of time-invariant individual heterogeneity. The results of this study may nevertheless indicate a lower negative impact of the conflict on education than if we were able to account for this potential unobservable, in the case that levels of support changed during the conflict. This is unlikely to have been the case in Timor Leste in light of the discussion in section 3.2. Another common omitted variable is the level of control of different armed factions. In the case of Timor Leste, the level of control of the Revolutionary Front for an Independent East Timor and the Indonesian troops is likely to vary with the geographical characteristics of each area as well as their proximity to West Timor. We control for this by including individual fixed effects in our specifications.

3.3.2 Identification strategy II: The impact of violence on primary school completion in 2007

In this section, we investigate the longer-term consequences of the violence experienced in 1999 in Timor Leste on primary school completion in 2007 among the cohorts of children analysed above. We then compare these results to the educational impact of the peaks of violence that occurred in earlier years of the conflict. To construct a measure of exposure to violence, we matched information on the number of killings (provided in the Human Rights Violations Database dataset)-which varies over time and across districts-to information on the year and district of birth of each individual (provided in the TLSS 2007 dataset). We focus on the number of killings as our main conflict variable because we find that it serves as a good proxy for the intensity of the conflict across time and space. The occurrence of killings largely tracked the movements of the Indonesian military operations (Silva and Ball, 2006). The number of killings also proxies for the destruction of homes and

infrastructure and the displacement of people during the 1999 wave of violence, given the manner in which it occurred (i.e., the scorched-earth technique employed by Indonesian troops as they moved toward West Timor). Matching this measure of violence to the year and district of birth of each individual allows us to identify whether and for how long each individual was exposed to the conflict during his or her primary school years. Our violence measure is defined as $V_{jt} = \sum_{a=7}^{12} v_{t+a}^{j}$ where each v_{t+a}^{j} takes a value of one if the individual was of primary school age in districts and years affected by the conflict. Specifically, j is the district of birth, t is the year of birth, and a is the primary school age (from 7 to 12). This measure ranges from zero to six if, from none to all six of a child's primary school years, respectively, were classified as exhibiting HVI. Because we only have information on the years in which individuals were supposed to have attended primary school,[9] we assume that the district of birth is the district where the child attended school at the time of the violent events.

We define districts and years of HVI as those in which the number of killings in that year and district are above a given threshold, defined as the mean of the number of killings plus one standard deviation. The years in which the conflict was the most intense, as defined by our threshold, are 1975-1979, 1983, and 1999. This observation coincides with the history of the conflict discussed in section 3.2 (see CAVR (2005)).[10]

The definition of HVI districts and years as a binary variable instead of a continuous one is primarily justified by our interest in capturing the incidence of violent conflict rather than its scale and magnitude. We have checked the robustness of all results to the use of a continuous variable and two different thresholds of violence intensity defined as the

[9] These are not the years in which the individuals actually attended school because we do not have access to this information. The existence of a delay in school means that the "supposed" years of attendance might not coincide with the "actual" years of school attendance. However, given the way in which we identify our control and treatment groups, we do not expect this difference to affect our results.

[10] The districts most affected by violence in the earlier years of the conflict are Baucau, Lautem, Viqueque, Ainaro, Manufahi, Manatuto, Aileu, Dili, Ermera, and Bobonaro. Those most affected by the 1999 violence are Dili, Ermera, Bobonaro, Covalima, Liquica, and Oecussi.

number of killings in each district and year (i) above the mean plus half of a standard deviation and (ii) above the mean plus two standard deviations. The results obtained are largely similar to those reported in this chapter.[11] In addition, the distribution of killings is highly right skewed, further justifying the use of a binary variable. A Kernel density plot of the number of killings (not shown) demonstrates that where and when the conflict events occurred, we observe a considerably higher number of violent events; otherwise, we observe a low to negligible number of events. Finally, and more important, the use of a discrete variable allows us to minimize potential biases deriving from the potential under-reporting of violent events. The Human Rights Violations Database dataset was compiled from voluntary statements, which may have resulted in biased reports. For instance, individuals living in remote areas or sick and disabled people may have not been able to report abuses, whereas victims of sexual abuse or traumatized people may not have reported their true levels of exposure to violence. In contrast, socially active individuals may have been more likely to volunteer information (Silva and Ball, 2006). Under these circumstances, the use of a continuous measure may lead to biased estimates reflecting potential self-selection into reporting violence (Leòn, 2012). The direction of this bias is impossible to predict a priori and depends on how unobservable characteristics related to under-reporting may be correlated with conflict exposure and the dependent variable.

To estimate the effect of the 1999 violence on school completion in 2007, we include individuals born between 1977 and 1992 in our sample. The treatment group includes individuals who were between 7 and 12 years old in 1999 in HVI districts (born between 1987 and 1992). We do not include individuals born after 1992 because they may have not completed primary school by 2007. The control group includes individuals who were not of primary school age in 1999 (born between 1977 and 1986).

[11] Results not shown and available upon request.

To analyse the impact of earlier peaks of violence, we focus our analysis on a sample of individuals born between 1968 and 1984. The treatment group includes individuals who were of primary school age between 1975 and 1979 and in 1983 (born between 1968 and 1976) in HVI districts. We exclude those born before 1968 because the schooling system was very different before the Indonesian troops invaded Dili in 1975. We also do not include individuals born between 1985 and 1986 as they may have been affected by the 1999 violence although placebo tests presented later indicate that they have not been affected. One interesting aspect of this analysis is that the treatment term informs us not only about the effects of exposure to HVI but also about the number of years of primary school affected by this exposure to violence.

Finally, we analyse the effect of the whole conflict on school attainment in 2007. For this purpose, we consider the full sample of individuals born between 1968 and 1992, where the treatment groups are those identified above and the control group includes individuals born between 1977 and 1986. This allows us to calculate the average educational effect of exposure to any period of the conflict for boys and girls in different age groups.

To analyse the effect of the conflict on primary school completion in 2007, we estimate the following equation:

$$G_{ihjt} = \beta V_{jt} + \alpha_j + \alpha_t + \alpha_j t + X_h^{'}\gamma + \epsilon_{ihjt} \tag{3.2}$$

where G_{ihjt} refers to primary school completion for individual i of household h born in district j in year t, defined as a binary variable equal to one if the individual has completed at least primary school and zero otherwise. The adoption of a binary variable as the dependent variable in place of a continuous one is motivated by our interest in primary school completion rather than school attainment in general. The education sector in Timor Leste is extremely under-developed, and most of the population is illiterate.

Primary education is therefore a major concern in the country. We examined whether our results are robust to the use of alternative definitions of the educational outcome measure. To investigate the robustness of the results to the use of a continuous rather than a binary variable, we used a maximum likelihood estimated ordered probit model for school grade attainment allowing for the censorship of those still in school. This estimation follows the methods proposed in Glewwe and Jacoby (1994), Holmes (2003), and Zhao and Glewwe (2010). None of the key findings on the impact of violence intensity on educational outcomes reported in this study are materially altered under this alternative approach.[12]

In the regression above, all standard errors are clustered at the year and district of birth levels. The term X_h is a vector of household characteristics (i.e., education of the household head and whether the household head is a farmer). The term V_{jt} is defined as above and identifies individuals exposed to HVI. β is our parameter of interest, indicating whether an additional year of primary school exposure to the conflict affects the probability of primary school completion after the conflict ended compared to an individual who was not affected by HVI during her primary school years. The two parameters α_j and α_t are fixed effects for the districts of birth and the years of birth, respectively, and the term $\alpha_j t$ represents district-specific linear trends.[13]

In table 3.3, we report the differences in average primary school completion in 2007 between individuals exposed to high- or low-violence intensity in each of the three samples analysed. These descriptive statistics show that boys exposed to HVI in 1999 (1977-1992 sample) exhibit a lower attainment rate than those who are less exposed to violence. The opposite is true for girls. Children exposed to earlier peaks of high intensity violence (1968-1984 sample) exhibit a lower completion rate than those living in districts and years

[12]The results of these exercises are available on request.

[13]We re-estimated the equation including a cubic district trend and a square root district trend to account for possible nonlinear trends across districts. We do not find any difference in the estimates, and we therefore only show the results that include a linear district trend. Results are available upon request.

in which the violence was not as intense.

The empirical strategy discussed above assumes that no systematic relationship exists between the intensity of the violence across districts and pre-conflict education levels at the district level. The existence of time-varying unobservables that are correlated with both the outcome and the conflict variables would bias our results. We have discussed this issue in the section above. We show here that the assumption also holds for the medium- and long-term analysis. The inclusion of district fixed effects in equation (3.2) allows us to account for time-invariant differences in education levels across districts. By including district-specific time trends, we account for any difference in trends across districts and hence for any time-varying characteristics in a given district. However, this identification strategy still relies on the assumption that there is no correlation between pre-conflict trends in education and violence in specific districts. To test for this, we conducted placebo tests on cohorts that supposedly were not exposed to the conflict during their primary school years (table 3.4).

Because the geographical variation of the conflict differs between the early years and 1999, we estimate two separate models by defining different violence-affected districts and placebo cohorts. We construct two violence-affected district dummies equal to one if the individual's district of birth is located in one of the HVI districts as defined above, during the early years of the conflict or during the 1999 violence, and zero otherwise. The first placebo test concentrates on the early years of the conflict. We are unable to analyse pre-conflict cohorts because, as explained above, the cohort born before 1968 would have attended a different school system. Therefore, we define those born between 1977 and 1980 as exposed placebo cohorts and compare them to those born between 1981 and 1984.[14] As a further check, we also analyse violence exposure for cohorts born between 1977 and

[14]The cohorts truly exposed to the early years of the conflict are those born between 1968 and 1976. In our placebo test, we examine the cohorts immediately following these.

1981 and compare them to those born between 1982 and 1986. The treatment term is the interaction between the placebo cohort and the HVI dummies. We expect to find no effect of "exposure" for cohorts who were not of primary school age but were born in districts with HVI. We repeat the analysis with a focus on the 1999 violence. Individuals born between 1982 and 1986 were not of primary school age in 1999. We define this latter cohort as the placebo cohort and compare their exposure to that of those born between 1977 and 1981 in high- and low-violence intensity districts. The results in table 3.4 show that cohorts who were not supposed to be of primary school age during the most violent years, but who were born in HVI districts, do not show significant differences in primary school completion rates relative to the same cohorts born in districts of low-intensity violence. This result supports our identification assumptions.

3.4 Empirical results

In this section, we discuss the results of the short- and long-term analyses.

3.4.1 School attendance in 2001

The results in table 3.5 report the impact of the two channels of exposure to violence in 1999 on school attendance in the 1999/00 and 2000/01 school years. We are primarily interested in the differential effects of the violence on school attendance in the post-violence period, T_3 (2000/01), relative to the pre-violence year, T_1 (1998/99).

The results show a negative and significant impact of displacement on school attendance in 2000/01 for the overall sample. We find that being affected by displacement alone (panel C, table 3.5) decreases school attendance by 8.5 percentage points on average, with stronger effects for boys. Individuals affected by both shocks experience a reduction in school attendance of 13.3 percentage points on average, with girls being more severely affected. We estimated a pooled model with interactions of the violence measures with the

female dummy. The results reported in panel C are statistically different between girls and boys, as in table 3.5. The effects are stronger for younger children. These results suggest that different violence channels affect school attendance in heterogeneous ways. School attendance is most severely disrupted for children, particularly girls, who are affected by both types of violence. Considering the channels separately, we observe that displacement is the most disruptive channel in terms of consequences on children's school attendance because all household assets are likely to have been lost. Ibáñez and Moya (2010) show similar evidence for Colombia. The destruction of a home affects household wealth, but perhaps less so if the household was able to retain other assets or to live with friends, neighbors, or relatives.

3.4.2 School completion in 2007

In table 3.6, panel A, we report the estimates of our analysis of the effect of the 1999 violence on primary school completion in 2007.

The coefficient for the violence measure is negative but not statistically significant. However, once we split the sample into boys and girls (columns 2 and 3),[15] the results show that boys exposed to violence during their primary school years are 18.3 percentage points less likely to have completed primary school eight years after the 1999 violence relative to boys not exposed to violence. This represents a 25 percent decrease in the probability of primary school completion. In contrast, we observe that girls exposed to the 1999 violence are 10.4 percentage points more likely to have completed primary school in 2007. This represents a 14 percent increase in the probability of girls completing primary school. We do not find any statistically significant differences across age groups.

We now turn to the effect of the peaks of violence in the earlier years of the conflict

[15]Similar to 2001, we estimated a pooled model for 2007 including an interaction term with the female dummy. The results show that the effects are statistically different between boys and girls in panels A and C.

on primary school completion in 2007. In table 3.6, panel B, we report the results for the sample of individuals born between 1968 and 1984. We find that an additional year of exposure decreases school completion in 2007 for all individuals by 2.6 percentage points and by 3 percentage points for boys. Therefore, the likelihood of primary school completion for boys was reduced (for an average exposure of one year and 10 months) by 5.6 percentage points. The effect is particularly strong for boys attending the last three years of primary school (grades four to six) (column 5). We do not find a significant effect for girls.

The results in table 3.6, panel C, report the effect of the overall conflict on primary school completion in 2007. The sample includes individuals born between 1968 and 1992. The results indicate the average effect of exposure to both the first years of the conflict and the 1999 violence. Because we examine the effects of both periods of high intensity violence and because only one year of primary school could have been affected during the 1999 violence, we have transformed our treatment term into a binary variable (exposed or not exposed during primary school) to ensure that we do not confound the results. These results indicate that boys exposed to the conflict in any period are, on average, 7.4 percentage points less likely to complete primary school in 2007 than those less exposed to violence. This effect represents a 10 percent decrease in the probability of primary school completion for boys. This effect is stronger among boys attending the last three years of primary school. The overall effect on girls is positive (most likely driven by the 1999 effects), corresponding to an 8.5 percent increase in the likelihood of primary school completion.

3.4.3 Discussion of the results

The results above indicate that violent conflict in Timor Leste had mixed effects on education. On average, the wave of violence in 1999 resulted in immediate hardships for the education of boys and girls. Girls, however, recovered from the negative consequences

of the 1999 violence in the medium term. When the same cohort was observed in 2007, girls affected by the conflict had a higher and statistically significant positive chance of completing primary school than girls who were not exposed to the violence. We find no effect of the earlier peaks of violence on girls' primary school completion, but we find a positive and statistically significant effect (at 10 percent) of the entire conflict on girls' primary school completion.

In contrast, boys exposed to the wave of violence in 1999 had a much lower probability of having completed primary school by 2007 relative to boys unaffected by the violent events. Earlier peaks of violence as well as the entire conflict have similar negative effects on the education of boys in Timor Leste, particularly among boys attending the last grades of primary school. The effect of earlier peaks of violence is smaller than the impact of the 1999 violence, although we observe the persistence of significant negative educational effects of the earlier years of the conflict in the longer term. The difference in the magnitudes of the impacts of different peaks of violence may be because individuals affected by the earlier violence may have had the opportunity to complete primary school or may reflect the particularly violent nature of the 1999 events. In all cases, boys were rather severely affected by violence over the 25 years of the Timor Leste conflict. The 1999 wave of violence in Timor Leste was brutal, but the recovery was rapid, as discussed in section 3.2. Although problems remain, violence-affected areas have clearly benefited from this reconstruction effort. This finding is in line with results reported for other conflict-affected countries in Bellows and Miguel (2006) and elsewhere. Our results show, however, that only girls affected by the violence seem to have been able to recover (and even improve) their educational outcomes.[16] The results for boys are persistently negative. An uneven negative impact of violent conflict on boys' educational outcomes is also reported in Akresh

[16] In a recent paper Valente (2013) also finds that conflict casualties increased female educational attainment in Nepal.

and de Walque (2011) for Rwanda and Verwimp and Bavel (2011) for Burundi.[17]

Given the discussion in section 3.2, it is unlikely that this result is explained by supply-side factors, such as the destruction of schools or the absence of teachers. The post-conflict reconstruction process had clear, positive impacts on the educational outcomes of girls exposed to violence, possibly because of a strong consideration of gender concerns in the UN interventions in Timor Leste (Olsson, 2009). However, it is highly unlikely that these programs would have been biased against educating boys. A more likely explanation is that the negative impact of the conflict on boys' education in Timor Leste is related to the different roles that boys and girls play within the household.

As mentioned in section 3.3, boys who were affected by the violence in 1999, on average, tended to work more and longer hours in 2001 (table 3.2). We estimated a reduced form regression of the incidence of conflict on child labor in the aftermath of the 1999 violence. Specifically we estimate the probability of children aged 10-14 years worked in the week prior to the 2001 survey. The results in table 3.A.1 in the Appendix indicate a positive correlation between conflict exposure (displacement) and the probability of boys working: boys affected by displacement are 11 percentage points more likely to work than boys unaffected by violence. Affected girls, however, are 3.6 percentage points less likely to work. Other studies have shown that child labor is a key factor in explaining low school enrolment rates in Timor Leste, particularly among boys. For instance, as Pedersen and Arneberg (1999) report, 'Poverty is the main reason why some 20 percent of children never get the chance to go to school. (...) Children, especially boys, work when their parents do not have jobs or their families are headed by single mothers' (pp. 83). This argument is in line with findings in the literature regarding household coping strategies in the face of adverse shocks, which have widely documented the use of children as an

[17] For a review of the literature on the impact of violent conflict on education, see Justino (2012a).

economic security mechanism (see Dasgupta (1993); Duryea et al. (2007); Nugent and Gillaspy (1983)). In areas experiencing violent conflicts, households may decide to replace dead, injured, absent, or disabled adult workers with children (if they have not also become fighters). Rodriguez and Sanchez (2009) analyse the effect of war on child labor and find that violent attacks by armed groups in Columbian municipalities significantly increased the probability of school dropout and the presence of children, particularly boys, in the labor market.

The above results suggest that household economic needs in Timor Leste may also have resulted in boys dropping out of school, a mechanism that may, in turn, explain the negative impact of the conflict on boys' education. This mechanism is not conclusive, and it is possible that school dropout may have occurred if boys joined armed groups as fighters or occupied other supporting roles. Data to test this alternative hypothesis are unavailable, but there are some indications that children joined both the pro-independence troops and paramilitary groups and militias. UNICEF (2001) states that '[b]oth the pro-independence and pro-integration forces in East Timor used children as armed combatants during period of the Indonesian occupation and its violent resolution after the 1999 referendum. On both sides of the conflict the age of child soldiers ranged from 10 to 18 years old, although most were between the age of 15 and 18 years old' (pp. 18). Given this age range, it is unlikely that our results are strongly driven by increases in the number of child soldiers. However, we cannot completely exclude this channel given the lack of sufficiently rigorous empirical evidence.

Taken together, the various pieces of evidence discussed above point to school dropout-most likely owing to economic necessity, but potentially for other reasons-as an important channel through which the conflict may have negatively affected educational outcomes among boys in Timor Leste. These effects may have considerable consequences for the country's future economic and political stability given the accumulation of negative edu-

cation shocks among boys over the 25-year conflict, which may have trapped a significant number of individuals in cycles of low human capital and low productivity. In particular, recent studies have reported that large numbers of young men who dropped out of school during the conflict in Timor Leste are currently members of gangs and martial arts groups in Dili, which are responsible for increases in insecurity and violence in Timor Leste (Kostner and Clark, 2007; Muggah et al., 2010; Scambary, 2009).

3.4.4 Robustness checks

We performed several robustness checks to address some important issues that may affect the results discussed above. In addition to the various validity checks reported in previous sections, we separately address the possible exposure of the 2007 sample to the civil violence that erupted in Timor Leste in 2006 and potential biases in the 2001 and 2007 results due to non-random migration patterns. Supporting tables are presented in the appendix. As mentioned in section 3.2, in 2006, Timor Leste experienced substantial internal civil strife owing to fighting between different factions of the independence forces. The violence in 2006 resulted in 37 killings, 2,000 severely damaged houses, 3,000 completely destroyed houses, and 150,000 displaced people (Muggah et al., 2010; Scambary, 2009). Most displaced people were located in the vicinity of Dili (where 65 internally displaced person camps were located) and were still displaced in 2007. Despite the decision to restart the 2007 survey once the violence had subsided (see footnote 3), it is possible that some of the results discussed in the section above are not due to exposure to the 1999 violence but due to exposure to the civil upheaval in 2006. To control for this potential exposure to the violence in 2006, we explore a variable in the 2007 dataset that captures whether an individual was absent from home in the past 12 months for security reasons (2.7 percent of the sample). Our calculations show that individuals who were absent from home for security reasons in 2006 all resided in Dili. Therefore, we believe that this dummy reliably

captures the level of exposure to the 2006 violence. The results in table 3.A.2 are nearly identical to those in table 3.6, indicating that our main conclusions are unlikely to be biased by the effects of the civil violence in 2006.

Another important concern is that some individuals migrated at some point in their lives.[18] The 2001 and 2007 datasets provide information on their places of birth and their current places of residence. The data do not allow us to establish when this migration occurred or whether these individuals migrated for conflict-related reasons. Thus, the migration variable is potentially noisy and prone to misclassification error. The direction of the endogeneity bias is difficult to predict a priori.[19] If, for instance, individuals did not choose their new place of residence randomly (Kondylis, 2010) and those who migrated went to areas in which economic conditions are typically better (for instance, urban areas), our results would likely be under-estimated. Conversely, the effect of the violence would be over-estimated if migrants relocated to places where they received inferior education. In addition, individuals who decided to migrate may differ from those who did not migrate. If this is the case and, for example, only wealthier and more educated households were able to migrate, then including these individuals in our estimates would underestimate the overall effect of the violence.

To assess whether the bias deriving from migration is a serious concern in our analysis, in tables 3.A.3 and 3.A.4, we present estimates from regressions that include a sample of individuals who never moved from their places of birth. These estimates test whether

[18] The migration decision should be interpreted as distinct from the occurrence of displacement in 1999 in Timor Leste. Although it is relatively common in the conflict literature to treat displacement as a migration decision (see, for instance, Chamarbagwala and Morán (2011) for Guatemala, Kondylis (2010) for Bosnia-Herzegovina, and Ibañez and Moya (2010) for Colombia), this is not an appropriate means of addressing displacement in the case of Timor Leste because our displacement variable is based on the respondents' reported displacement experience rather than a migration outcome. We have also estimated the determinants of migration and found that displacement does not play a significant role in migration decisions.

[19] It is important to note that issues regarding the potential endogeneity of the migration decision need to be considered as distinct in this context from potential endogeneity concerns regarding the displacement measure, which have been discussed in section 3.3.

the results in sections 3.4.1 and 3.4.2 hold when we restrict the sample to non-migrants. The results are broadly comparable in terms of magnitude, signs, and significance to those obtained using the full sample. In addition, the proportions of individuals who migrated to a different place are 13 percent of the 2001 sample and 19 percent and 24 percent of the 2007 samples (the 1977-92 and 1968-84 cohorts, respectively). This finding suggests that even in the extreme scenario where the estimated effect was zero for migrants, the overall estimated effect would only be attenuated by approximately one-quarter of its value. We are therefore quite confident that our results are not biased as a result of migration choices.

3.5 Concluding remarks

The aim of this essay was to examine the effects of the 25 years of conflict in Timor Leste on educational outcomes among boys and girls exposed to violence. We began by analysing the impact of the wave of violence that occurred during the withdrawal of Indonesian troops in 1999. We first analysed the short-term impact of the 1999 violence on primary school attendance in 2001 and its longer-term impact on school completion for the same cohorts of children observed again in 2007. We compared these latter results to the impacts of the peaks of violence in the 1970s and 1980s on schooling outcomes observed in 2007 (among those who were of primary school age at the time of the various violent events) and to the overall average educational impact of the conflict. This approach enabled us to compare the impact of a long-duration conflict on educational outcomes during the overall conflict and during peaks of violence.

In line with the existing literature on the effects of violent conflict on educational outcomes, we find that the conflict in Timor Leste led to considerable adverse impacts on educational outcomes, particularly among boys exposed to the violence. We find, however, that the impact of the conflict on girls' education, although negative in the short-term in terms of school attendance, did not hinder their school attainment in the longer term

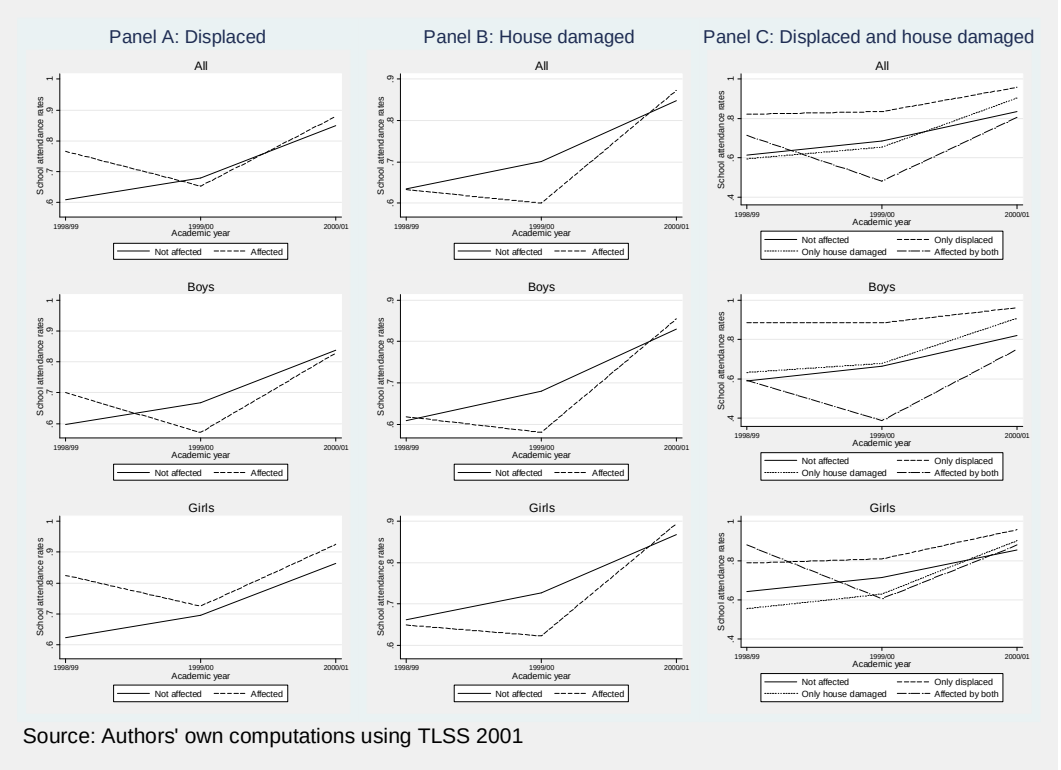
because they were able to benefit from the rapid reconstruction of the education system in violence-affected areas. In contrast, the 25 years of violent conflict had a clearly negative impact on the education of boys in Timor Leste that persisted across generations. This result is consistent for different peaks of violence throughout the conflict in Timor Leste. Generations of young Timorese boys have experienced considerable reductions in their accumulation of human capital, which may now be reflected in increases in insecurity, unemployment, and violence in the country since 2006.

We have discussed evidence suggesting that the negative impact of violence on boys' education is due to boys dropping out of school. This is likely to be caused by household investment trade-offs between education and economic survival, where boys would have been removed from school to participate in household economic activities. It is also possible that a small number of young boys may have dropped out of school to join armed groups.

These results have important policy implications. One implication is the importance of educational recovery in areas affected by violent conflict. The Timor Leste case suggests that early recovery may have positive results for the lives of children (girls, in this case). Another key implication is that reconstruction policies must pay greater attention to their redistributive impacts across genders and different population characteristics. Although girls recovered quickly from the conflict, boys did not, despite the large investment in the early recovery of the education system in Timor Leste. The evidence for Timor Leste suggests that boys were very vulnerable to both the direct effects of violence on education outcomes and indirect effects through household welfare mechanisms. This result implies that much more attention must be paid to understanding how children are affected by violent conflict and the different roles girls and boys assume during and after the conflict because these are likely to perpetuate the risks associated with renewed conflict and persistent vulnerabilities across generations.

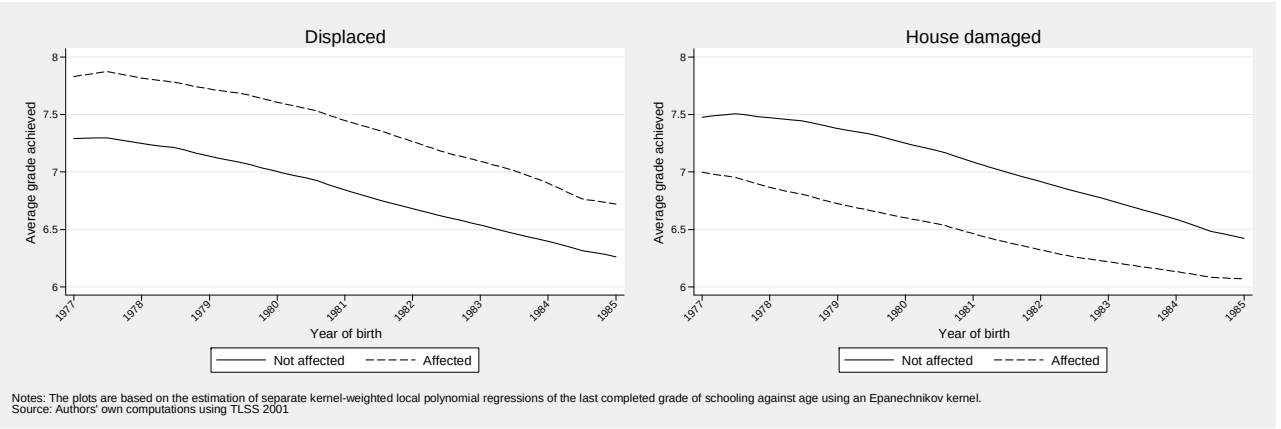
Figures

Figure 3.1: School Attendance Rates by Channel of Violence Exposure



Source: Authors' own computations using TLSS 2001

Figure 3.2: Pre-conflict Trends in Education Levels



Notes: The plots are based on the estimation of separate kernel-weighted local polynomial regressions of the last completed grade of schooling against age using an Epanechnikov kernel.
Source: Authors' own computations using TLSS 2001

Tables

Table 3.1: Attendance rates of children aged 7-12 years between 1998 and 2001

	All: 8–11 years old				Younger cohort: 8–9 years old				Older cohort: 10–11 years old			
	All	Boys	Girls	*t* test	All	Boys	Girls	*t* test	All	Boys	Girls	*t* test
1998/99	0.634	0.611	0.659		0.509	0.498	0.521		0.750	0.720	0.782	
	(0.012)	(0.018)	(0.017)	n.s.	(0.020)	(0.027)	(0.028)	n.s.	(0.018)	(0.026)	(0.025)	n.s.
1999/00	0.676	0.654	0.700		0.622	0.602	0.647		0.726	0.705	0.749	
	(0.012)	(0.017)	(0.017)	n.s.	(0.019)	(0.027)	(0.028)	n.s.	(0.018)	(0.026)	(0.026)	n.s.
2000/01	0.854	0.836	0.874		0.822	0.789	0.860		0.884	0.881	0.887	
	(0.014)	(0.019)	(0.019)	*	(0.022)	(0.030)	(0.031)	**	(0.021)	(0.029)	(0.029)	n.s.
N	966	512	454		466	251	215		500	261	239	

Notes: Authors' computations using TLSS 2001. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. n.s. = not statistically significant. We consider the same cohort over time: the sample is aged 7–10 years in 1998, 8–11 years in 1999, and 9–12 years in 2000.

Table 3.2: Individual and household characteristics by channel of violence exposure in 2001

	All children 7-12						Boys 7-12						Girls 7-12					
	Displaced			House damaged			Displaced			House damaged			Displaced			House damaged		
	0	1	*t* test	0	1	*t* test	0	1	*t* test	0	1	*t* test	0	1	*t* test	0	1	*t* test
Panel A – All children (7-12 years old)																		
Being female	0.472	0.500		0.484	0.454	n.s.												
Speaking Indonesian	0.575	0.720	***	0.584	0.632	n.s.	0.577	0.701	**	0.580	0.634	n.s.	0.574	0.738	***	0.589	0.631	
Speaking Portuguese	0.028	0.033	n.s.	0.030	0.027	n.s.	0.032	0.028	n.s.	0.031	0.035	n.s.	0.024	0.037	n.s.	0.029	0.018	
HH head is a farmer	0.646	0.556	**	0.623	0.659	n.s.	0.649	0.570	n.s.	0.639	0.634	n.s.	0.642	0.542	*	0.606	0.690	**
Education grade of HH head	3.114	3.651	n.s.	3.332	2.783	**	2.954	3.210	n.s.	3.099	2.685	n.s.	3.293	4.084	n.s.	3.581	2.899	*
Education grade of the mother	1.870	2.785	***	2.200	1.435	***	1.827	2.252	n.s.	2.061	1.406	**	1.918	3.318	***	2.348	1.470	***
Education grade of the father	2.824	3.495	*	3.037	2.589	**	2.802	2.869	n.s.	2.944	2.446	n.s.	2.848	4.121	**	3.136	2.762	
Living in urban areas	0.402	0.533	***	0.419	0.427	n.s.	0.396	0.551	***	0.413	0.431	n.s.	0.409	0.514	**	0.426	0.423	
Per capita monthly HH expenditure	238,963	262,113	n.s.	244,940	234,904	n.s.	250,901	249,806	n.s.	245,971	263,914	n.s.	225,635	274,421	*	243,843	200,024	***
N	1236	214		1080	370		652	107		557	202		584	107		523	168	
Panel B – Children aged 10–12 (labor market characteristics)																		
Has worked in the past seven days	0.063	0.088	n.s.	0.070	0.056	n.s.	0.054	0.167	**	0.071	0.063	n.s.	0.073	0.019	**	0.070	0.048	n.s.
Working hours	1.468	2.098	n.s.	1.722	1.084	n.s.	1.117	4.292	**	1.582	1.406	n.s.	1.857	0.148	***	1.868	0.711	n.s.
Has performed domestic chores	0.902	0.912	n.s.	0.897	0.922	n.s.	0.889	0.854	n.s.	0.888	0.875	n.s.	0.916	0.963	n.s.	0.907	0.976	n.s.
N	602	102		525	179		316	48		268	96		286	54		257	83	

Notes*:* Authors' computations using TLSS 2001. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. n.s. = not statistically significant. In the title, 0 refers to not affected individuals while 1 refers to affected individuals. HH indicates household. Per capita monthly HH expenditure is expressed in Rupiah in real values using CPI of 2001.

Table 3.3: Average primary school completion in 2007

	All			Boys			Girls		
	Low-intensity violence	High- intensity violence	*t* test	Low-intensity violence	High- intensity violence	*t* test	Low-intensity violence	High- intensity violence	*t* test
Panel A – All primary school age children									
1977–1992 sample	0.725	0.724	n.s	0.752	0.709	**	0.698	0.739	**
	(0.006)	(0.013)		(0.008)	(0.020)		(0.008)	(0.017)	
1968–1984 sample	0.624	0.572	***	0.680	0.658	n.s.	0.569	0.472	***
	(0.007)	(0.023)		(0.010)	(0.032)		(0.009)	(0.034)	
1968–1992 sample	0.679	0.674	n.s	0.720	0.692	**	0.636	0.654	n.s.
	(0.005)	(0.009)		(0.007)	(0.013)		(0.006)	(0.013)	
Panel B – Children of grade 1–3 age									
1977–1992 sample	0.731	0.692	**	0.751	0.673	***	0.709	0.711	n.s.
	(0.005)	(0.019)		(0.008)	(0.029)		(0.007)	(0.025)	
1968–1984 sample	0.623	0.571	***	0.679	0.659	n.s.	0.567	0.471	***
	(0.007)	(0.024)		(0.010)	(0.032)		(0.010)	(0.035)	
1968–1992 sample	0.687	0.637	***	0.723	0.666	***	0.650	0.605	**
	(0.004)	(0.012)		(0.006)	(0.016)		(0.006)	(0.016)	
Panel C – Children of grade 4–6 age									
1977–1992 sample	0.719	0.759	**	0.738	0.749	n.s.	0.700	0.769	***
	(0.005)	(0.018)		(0.008)	(0.028)		(0.007)	(0.023)	
1968–1984 sample	0.622	0.524	***	0.680	0.634	n.s.	0.564	0.385	***
	(0.007)	(0.037)		(0.010)	(0.051)		(0.009)	(0.054)	
1968–1992 sample	0.675	0.690	n.s.	0.711	0.713	n.s.	0.638	0.664	n.s.
	(0.004)	(0.014)		(0.006)	(0.021)		(0.006)	(0.019)	

Notes: Authors' computations using TLSS 2007. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. n.s. = not statistically significant.

Table 3.4: Placebo test for differences in trends in ecucation levels

	1977–1984 sample			1977–1986 sample			1977–1986 sample		
	(1) All	(2) Boys	(3) Girls	(4) All	(5) Boys	(6) Girls	(7) All	(8) Boys	(9) Girls
HVI district*Cohort 1977–80	0.062	0.070	0.052						
	(0.047)	(0.054)	(0.061)						
HVI district*Cohort 1977–81				0.021	0.059	−0.018			
				(0.044)	(0.048)	(0.058)			
HVI district(a)	0.014	0.031	−0.003	0.040	0.014	0.063			
	(0.031)	(0.032)	(0.043)	(0.030)	(0.029)	(0.043)			
HVI district*Cohort 1982–86							−0.015	0.044	−0.078
							(0.043)	(0.050)	(0.054)
HVI district(b)							−0.051	−0.037	−0.060
							(0.031)	(0.040)	(0.038)
N	2,542	1,255	1,287	3,402	1,699	1,703	3,402	1,699	1,703
R-squared	0.158	0.156	0.153	0.140	0.131	0.141	0.141	0.130	0.151

Notes: Authors' computations using TLSS 2007. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses clustered at the year of birth * district level. Regressions include year and district fixed effects and controls (whether the household head is a farmer and the household head's level of education). HVI district(a) equals one if the individual's district of birth is found to be a conflict-affected district during the early years of conflict (1975–1979 and 1983), as defined by our violence measure. HVI district(b) equals one if the individual's district of birth is found to be a conflict-affected district during the 1999 violence as defined by our violence measure.

Table 3.5: Impact of 1999 violence on school attendance in 2001

	(1) All 8–11	(2) Boys 8–11	(3) Girls 8–11	(4) All 8–9	(5) Boys 8–9	(6) Girls 8–9	(7) All 10–11	(8) Boys 10–11	(9) Girls 10–11
Panel A – Impact of displacement									
D*T_2	−0.184***	−0.199***	−0.172***	−0.198***	−0.212***	−0.185**	−0.188***	−0.209**	−0.170**
	(0.045)	(0.056)	(0.060)	(0.047)	(0.065)	(0.074)	(0.061)	(0.088)	(0.077)
D*T_3	−0.127***	−0.111**	−0.141***	−0.182***	−0.138*	−0.233***	−0.089**	−0.106*	−0.066
	(0.037)	(0.049)	(0.048)	(0.053)	(0.077)	(0.071)	(0.038)	(0.055)	(0.055)
N	2,898	1,536	1,362	1,398	753	645	1,500	783	717
R-squared	0.151	0.155	0.146	0.217	0.199	0.241	0.110	0.130	0.091
Panel B – Impact of house damage									
H* T_2	−0.101**	−0.109**	−0.091*	−0.075	−0.137*	−0.012	−0.129***	−0.077	−0.196***
	(0.042)	(0.054)	(0.054)	(0.051)	(0.070)	(0.070)	(0.048)	(0.067)	(0.059)
H* T_3	0.027	0.016	0.040	0.046	0.027	0.061	0.004	0.014	−0.016
	(0.041)	(0.051)	(0.052)	(0.059)	(0.077)	(0.078)	(0.037)	(0.052)	(0.056)
N	2,898	1,536	1,362	1,398	753	645	1,500	783	717
R-squared	0.147	0.153	0.142	0.209	0.198	0.226	0.110	0.122	0.106
Panel C: Impact of displacement and house damage									
D* T_2	−0.060	−0.076	−0.050	−0.070	−0.086	−0.058	−0.079	−0.122	−0.064
	(0.049)	(0.060)	(0.062)	(0.057)	(0.068)	(0.087)	(0.069)	(0.109)	(0.085)
D* T_3	−0.085*	−0.154***	−0.041	−0.153**	−0.248***	−0.098	−0.039	−0.048	−0.020
	(0.047)	(0.059)	(0.065)	(0.064)	(0.070)	(0.100)	(0.055)	(0.110)	(0.065)
H* T_2	−0.015	−0.030	0.002	0.027	−0.039	0.084	−0.062	−0.011	−0.130**
	(0.050)	(0.068)	(0.057)	(0.063)	(0.091)	(0.077)	(0.053)	(0.076)	(0.058)
H*T_3	0.087*	0.045	0.134**	0.114	0.036	0.173**	0.052	0.065	0.028
	(0.050)	(0.064)	(0.058)	(0.072)	(0.096)	(0.086)	(0.044)	(0.063)	(0.057)
D*H* T_2	−0.233**	−0.174	−0.296**	−0.282***	−0.193	−0.364**	−0.156	−0.116	−0.158
	(0.094)	(0.114)	(0.123)	(0.104)	(0.136)	(0.152)	(0.122)	(0.171)	(0.151)
D*H* T_3	−0.133*	0.037	−0.304***	−0.122	0.166	−0.413***	−0.123	−0.129	−0.119
	(0.077)	(0.103)	(0.087)	(0.114)	(0.158)	(0.121)	(0.075)	(0.128)	(0.098)
N	2,898	1,536	1,362	1,398	753	645	1,500	783	717
R-squared	0.162	0.164	0.163	0.228	0.217	0.257	0.122	0.134	0.117

Notes: Authors' computations using TLSS 2001. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table reports fixed effect estimates. Robust standard errors in parentheses are clustered at the village level. Regressions include time effects (T_2 refers to 1999/00; T_3 refers to 2000/01). D, H, and D*H are dummies, respectively defined as one if individual was displaced with the whole household, whether the house was completely damaged, and whether the individual was affected by both violent shocks.

Table 3.6: Impact of conflict on primary school completion in 2007

	(1) All	(2) Boys	(3) Girls	(4) All	(5) Boys	(6) Girls
Panel A – Effect of 1999 violence (1977-1992)						
Years of prim. school in HVI	−0.041	−0.183***	0.104**			
	(0.029)	(0.044)	(0.047)			
Years of grade 1–3 in HVI				−0.069*	−0.210***	0.080
				(0.038)	(0.056)	(0.064)
Years of grade 4–6 in HVI				−0.040	−0.183***	0.105**
				(0.029)	(0.044)	(0.048)
N	6,676	3,383	3,293	6,676	3,383	3,293
R-squared	0.150	0.144	0.180	0.150	0.144	0.180
Panel B – Effect of early years of conflict (1968-1984)						
Years of prim. school in HVI	−0.026**	−0.030**	−0.021			
	(0.011)	(0.014)	(0.017)			
Years of grade 1–3 in HVI				−0.021*	−0.022	−0.018
				(0.012)	(0.016)	(0.020)
Years of grade 4–6 in HVI				−0.040**	−0.054**	−0.031
				(0.018)	(0.021)	(0.028)
N	5,195	2,625	2,570	5,195	2,625	2,570
R-squared	0.338	0.358	0.318	0.338	0.358	0.318
Panel C – Effect of entire conflict (1968-1992)						
HVI in primary school	−0.012	−0.074***	0.055*			
	(0.020)	(0.027)	(0.030)			
HVI in grade 1–3				−0.006	−0.035	0.031
				(0.019)	(0.023)	(0.029)
HVI in grade 4–6				−0.019	−0.075***	0.044
				(0.019)	(0.027)	(0.029)
N	9,329	4,753	4,576	9,329	4,753	4,576
R-squared	0.241	0.231	0.266	0.241	0.231	0.266

Notes: Authors' computations using TLSS 2007. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses clustered at the year of birth * district level. Regressions include year and district fixed effects, district time trend (defined as the interaction between the district category and birth year), and controls (whether the household head is a farmer and the household head's level of education).

3.A Appendix

Table 3.A.1: Probability of child labour in 2000/01

	(1) All	(2) Boys	(3) Girls
Displaced	0.021	0.109**	-0.036*
	(0.035)	(0.072)	(0.021)
House damage	-0.017	-0.016	-0.019
	(0.018)	(0.026)	(0.019)
Both shocks	-0.008	-0.032	0.015
	(0.037)	(0.038)	(0.070)
Controls	Yes	Yes	Yes
Obs.	1082	579	503
Pseudo R-squared	0.080	0.082	0.129

Notes: Authors' computations using TLSS 2001. We report marginal effects from a probit regression model. The sample includes children aged 10-14 in 2000/01. Controls include: household per capita expenditures, whether they speak Indonesian, grades completed by the mother and father, the occupation of the head of household, gender of the head of household, household size, and region of residence. * p<0.10, ** p<0.05, *** p<0.01

Table 3.A.2: Robustness check: impact of conflict on primary school completion in 2007, controlling for 2007 civil violence

	Impact of 1999 violence (1977–1992 sample)			Impact of early years of conflict (1968–1984 sample)		
	All	Boys	Girls	All	Boys	Girls
Years of prim. school in HVI	−0.042	−0.186***	0.105**	−0.026**	−0.032**	−0.021
	(0.029)	(0.044)	(0.047)	(0.011)	(0.014)	(0.017)
Absent home past 12 months	0.083***	0.066	0.104***	0.086***	0.095**	0.079*
	(0.023)	(0.043)	(0.032)	(0.030)	(0.040)	(0.045)
N	6,676	3,383	3,293	5,195	2,625	2,570
R-squared	0.151	0.144	0.181	0.339	0.359	0.318

Notes*:* Authors' computations using TLSS 2007. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses clustered at the year of birth * district level. Regressions include year and district fixed effects, district time trend (defined as the interaction between the district category and birth year), and controls (whether the household head is a farmer and the household head's level of education).

Table 3.A.3: Robustness check: impact of 1999 violence on school attendance in 2001, non-migrant sample

	(1) All	(2) Boys	(3) Girls	(4) All	(5) Boys	(6) Girls	(7) All	(8) Boys	(9) Girls
$D*T_2$	−0.200***	−0.213***	−0.188**				−0.053	−0.071	−0.042
	(0.052)	(0.063)	(0.072)				(0.058)	(0.067)	(0.076)
$D*T_3$	−0.144***	−0.130***	−0.157***				−0.082	−0.150**	−0.037
	(0.038)	(0.050)	(0.053)				(0.053)	(0.066)	(0.074)
$H* T_2$				−0.124***	−0.119*	−0.129**	−0.027	−0.031	−0.022
				(0.047)	(0.061)	(0.062)	(0.057)	(0.077)	(0.067)
$H*T_3$				0.005	0.003	0.007	0.077	0.043	0.118*
				(0.044)	(0.054)	(0.056)	(0.055)	(0.070)	(0.065)
$D*H*T_2$							−0.263**	−0.206	−0.326**
							(0.108)	(0.129)	(0.143)
$D*H*T_3$							−0.167*	0.002	−0.343***
							(0.088)	(0.113)	(0.096)
N	2,553	1,383	1,170	2,553	1,383	1,170	2,553	1,383	1,170
R-squared	0.157	0.161	0.154	0.154	0.157	0.150	0.169	0.169	0.173

Notes: Authors' computations using TLSS 2001. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table reports fixed effect estimates. Robust standard errors in parentheses clustered at the village level. Regressions include time effects (T_2 refers to the 1999/00 school year, and T_3 refers to the 2000/01 school year); D, H, and D*H are dummies, respectively, defined as 1 if the individual was displaced with the whole household, whether the house was completely damaged, and whether the individual was affected by both violent shocks.

Table 3.A.4: Robustness check: impact of conflict on primary school completion in 2007, non-migrant sample

	Impact of 1999 violence (1977–1992 sample)			Impact of early years of conflict (1968–1984 sample)		
	All	Boys	Girls	All	Boys	Girls
Years of prim. school in HVI	−0.033	−0.166***	0.103*	−0.015	−0.018	−0.014
	(0.036)	(0.054)	(0.057)	(0.013)	(0.016)	(0.021)
N	5,446	2,803	2,643	3,963	2,041	1,922
R-squared	0.151	0.150	0.178	0.330	0.374	0.292

Notes: Authors' computations using TLSS 2007. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses clustered at the year of birth * district level. Regressions include year and district fixed effects, district time trend (defined as the interaction between the district category and birth year), and controls (whether the household head is a farmer and the household head's level of education).

Conclusions

This thesis has provided an empirical analysis of child labour and female empowerment in Nepal, and of conflict in Timor Leste, looking at specific aspects that relate to children, women and economic development. The three studies offer important contributions on issues which have received only limited attention to date in the development economics literature.

The first chapter analysed child labour among farm households of rural Nepal. The estimates suggested that children's contribution on the farm is not negligible and might be necessary for the subsistence of these households. However, reasons other than poverty appear to explain part of the child labour supply in agricultural households. Imperfections in the labour market may in part explain the labour supply of children, particularly of boys, in those households that are not at the top-end of the land distribution.

In the second chapter, we investigated the effects of an increase in female participation in the Executive Committees of Community Forest User Groups of Nepal on firewood collection. The results revealed that a higher participation of women reduces firewood collection. This suggests that, given the interests that women have in ensuring the availability of products essential to their daily lives, once in a decision making position, women favour decisions towards a sustainable extraction of firewood and ultimately to forest protection.

The last chapter examined the short-term and longer-term impacts of a widely-ignored but long-lasting conflict - the Timor Leste conflict that endured for 25 years - on the

educational outcomes of girls and boys. We found that the conflict had considerable adverse effects particularly on boys which also hindered their school attainment in the longer term. In contrast, the educational outcomes of girls, despite being negatively affected in the short-term, did not exhibit these adverse consequences in the longer term. Girls have been able to benefit from the rapid reconstruction process of the education system. The findings suggest instead that boys have not equally benefited from this process, possibly because of household trade-offs between education and economic survival, whereby many boys may have been removed from school and put to work.

Our analysis provides some novel contributions in understanding how child labour in agricultural households reacts to changing economic conditions and how children's educational outcomes are affected by violent events. In particular, policies focusing on the removal of constraints to the rural labour markets and on early post-conflict interventions may eliminate some factors which hinder children's development and ultimately economic development. In general, our results suggest that policies need to place particular attention to how differently boys and girls react to changing economic conditions and to violent conflicts. Most of the gender differences we identify are driven by the different roles that boys and girls assume within the household in these contexts. The existence of social and cultural norms in these countries partly explains these differences.

We also offer a unique analysis of the link between women and economic development. The recognition of a greater role for women in forestry seem to be beneficial to the effectiveness of local collective action institutions. This study offers an important contribution suggesting that policies that place specific provisions on the gender composition of decision-making bodies of local collective action institutions may ultimately improve economic development.

Although this thesis explores in depth important relationships among children, women and economic development, there are some limitations which we need to highlight, and

offer some suggestions for future research.

In the first chapter, we have not formally established whether the estimated contribution of child labour to the farm is necessary to households to meet their subsistence needs. Future research may focus on developing the theoretical model by adding a subsistence constraint, hence deriving testable propositions. This development in particular would enrich our analysis as it would allow us to establish more clearly not only how much children contribute but also whether this contribution is essential to the family.

Further, our data does not contain information on the specific task in which each type of labourer is involved on the farm and the use of inputs (including labour) on each single output and on different types of plots. Progress in the analysis could be made if data on this is made available. It would allow us to measure the productivity of each type of worker on a single activity, on each single output and on plots under different modes of land operation. This would yield additional insights into differences in contribution between, for instance, child and adult family labour, boys and girls, family and hired labour.

In addition, due to data limitations, we do not test for the equality between marginal product of labour (the shadow wage) and market wages. Imperfections in labour markets, transaction costs and any allocative inefficiency in the use of labour inputs may create a wedge between these two outcomes. Our results suggest such a difference. However, a forward step we could make is to provide shadow wage estimates that account for such allocative inefficiencies. Given the importance of quantifying correctly the contribution of child labour to the family farms, this would provide more refined estimates of shadow wages. It would inform better on imperfections in the markets and of any allocative inefficiencies. This adjusted measure can then be used in the structural labour supply estimation. One relevant methodology is that developed by Barrett et al. (2008) but further research can concentrate on exploring other methodologies that require less detailed

data.

Finally, the estimates from the reduced form model offered results that merit further investigation. Additional research may concentrate on looking more deeply at the role of the mode of operation of land in explaining child labour within agricultural households.

In the second chapter, the use of two data sources, specifically the household surveys and the census of FUGs offers unique information for our analysis. However, future research may concentrate in also looking at the variation in the characteristics of groups in the same village and in accounting for heterogeneity between households that are members of FUGs or not. The availability of more detailed data on FUG membership at the household level could serve for these purposes and give additional insights on the role of women within FUGs.

In addition, an interesting development of our analysis would be to look at the distributional effects of an increased role of women (i.e., equity). Our results do not allow us to establish whether the reduction in firewood extraction generated by an increase in female participation, despite favouring the protection of forests, may hurt or benefit some portions of the population more than others. Data on FUGs' participation at the household level may serve to explain further our results looking at heterogeneous effects, thus shedding light on equity issues. The analysis of the distribution of benefits of FUGs and whether it is equal across population groups is as important as ensuring that these groups are effective in protecting the forests. In addition, the way the surplus income generated within the FUG is spent locally can be affected by the increased role of women within the FUGs. This is also an interesting aspect that is worth exploring. Women may invest disproportionately on goods that are related directly to their concerns (e.g., children related goods and outcomes) and on the welfare of their households. Additional outcomes also merit further exploration. For example, increased female participation may also favourably affect the time women and children spend in collecting firewood and also

their health. This suggested further research may inform us about the direct effect of empowering women on children's outcomes and development.

A recently released nationally representative survey commissioned by the Ministry of Forest and Soil Conservation (MFSC) jointly with some bilateral donors, which cover 137 FUGs in 47 districts based on 2,069 households, can be exploited for this type of future research. The data is extremely useful as it includes information at the household level on a wide range of characteristics of the FUGs, and specifically of the Executive Committees, including the gender composition.

Finally the role that donors and the conflict played in relationship to the participation of women in the ECs of FUGs is also worth exploring in future research.

In the third chapter, we offer suggestive explanations for the different effects we find between boys and girls. Additional data would be helpful in further investigating the mechanisms we are suggesting and also to exclude others. We explain the reasons why we exclude supply side mechanisms as potential explanations. However, data on the number of schools and the number of teachers before and after the conflict would allow us to empirically test the role of these mechanisms in explaining our results. In addition, we only offer qualitative evidence regarding the low percentage of boys who join armed groups. Data on the number of child soldiers would also offer additional insights to reinforce our arguments. Finally, while our research question focuses on the effects of conflict on educational outcomes, our findings suggest the need for further research to investigate the effects on the labour outcomes of those whose education was affected during the conflict. The analysis of gender differentials may be of particular interest.

In summary, this thesis makes relevant contributions in highlighting specific aspects that relate children and women to economic development. We provide a useful basis for investigating further issues that have not been adequately addressed in the literature. Despite the fact that Nepal and Timor Leste offered two ideal contexts for our analysis,

our results provide some external validity and suggest that policies and further research may also be applied in similar context of other developing countries.

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